# TEXTURAL AND MINERALOGICAL CHARACTERISTICS OF NEARSHORE SEDIMENTS, EASTERN BAFFIN ISLAND

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Data Report
C-CORE Publication 86-2
March 1986

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ISBN 0-88901-093-5

**ACKNOWLEDGEMENTS**

I would like to thank Captain F. Mauger and the officers and crew of the **CSS HUDSON** for their assistance in sample collection. J.P. Syvitski, R. Taylor and K. Asprey, Atlantic Geoscience Centre (AGC), are gratefully acknowledged for their help in the collection of beach and delta samples and for many beneficial discussions. The content of this report benefitted from discussions and critical reviews by J.V. Barrie, C-CORE. Thanks are extended to C. Coombs and D. King for their patience and expertise in the typing and drafting of this report. The report was prepared for publication by E. Nesbitt-Friis.

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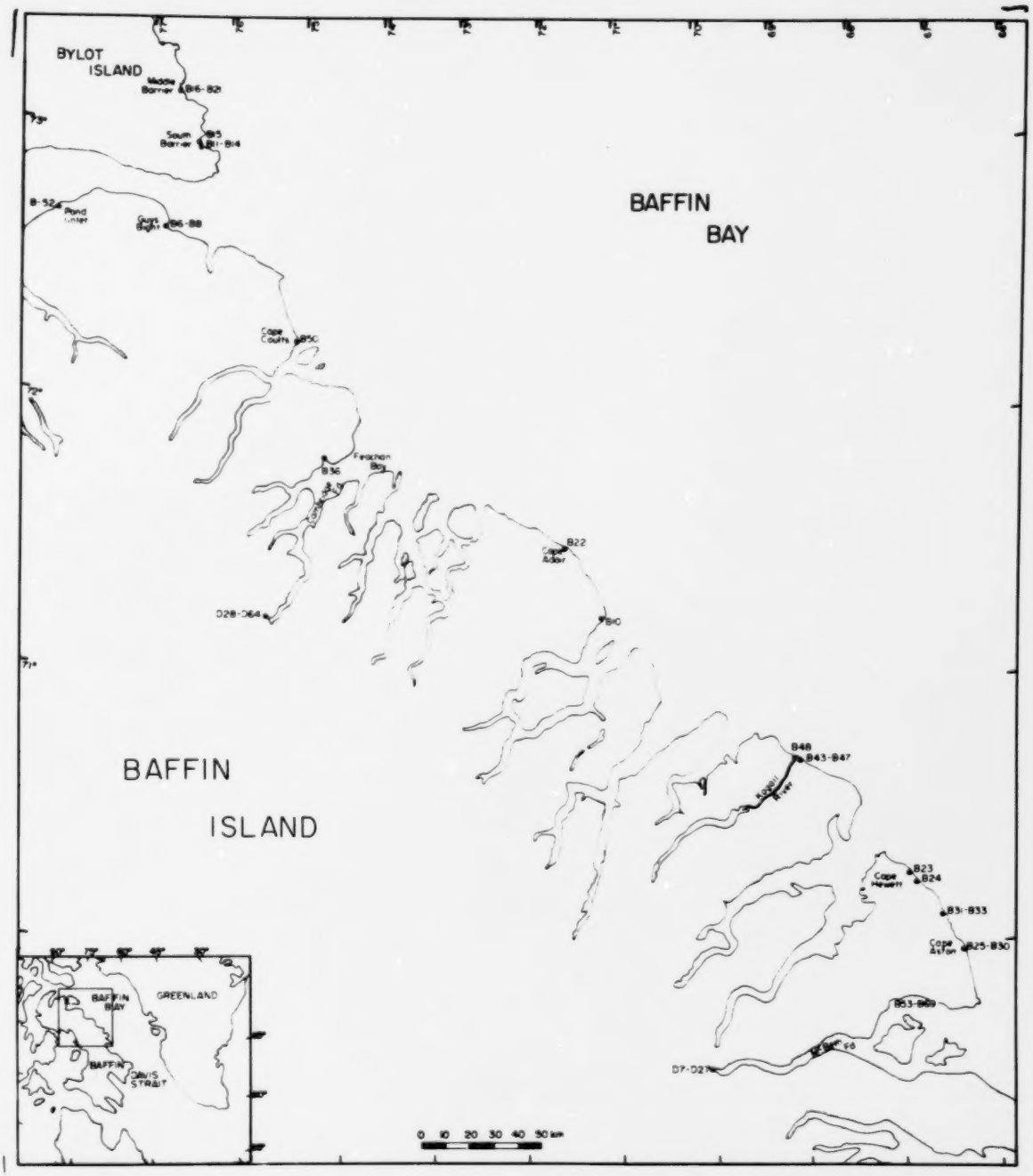


**Figure 1. Study Area and Sample Location**

## 1. INTRODUCTION

This report provides textural and mineralogical data from sands found within 4 shallow marine environments of eastern Baffin Island: coastal beaches, a side-entry beach complex, fjord deltas (sandurs) and prodeltas (Figure 1). Local and regional variations in sand texture and heavy mineralogy as well as possible causes thereof are discussed. The long-term objective of this project is to establish a sediment model for sand transport and deposition in arctic nearshore environments as it relates to the development of heavy mineral placer deposits.

The investigation forms one component of the Sedimentology of Arctic Fjords Experiment (SAFE), a multidisciplinary program detailing oceanographic, geologic and biological concerns in arctic fjords (Syvtiski and Schafer). SAFE was initiated by the Geological Survey of Canada at the Atlantic Geoscience Centre and involves the participation of three federal government branches and eight universities.

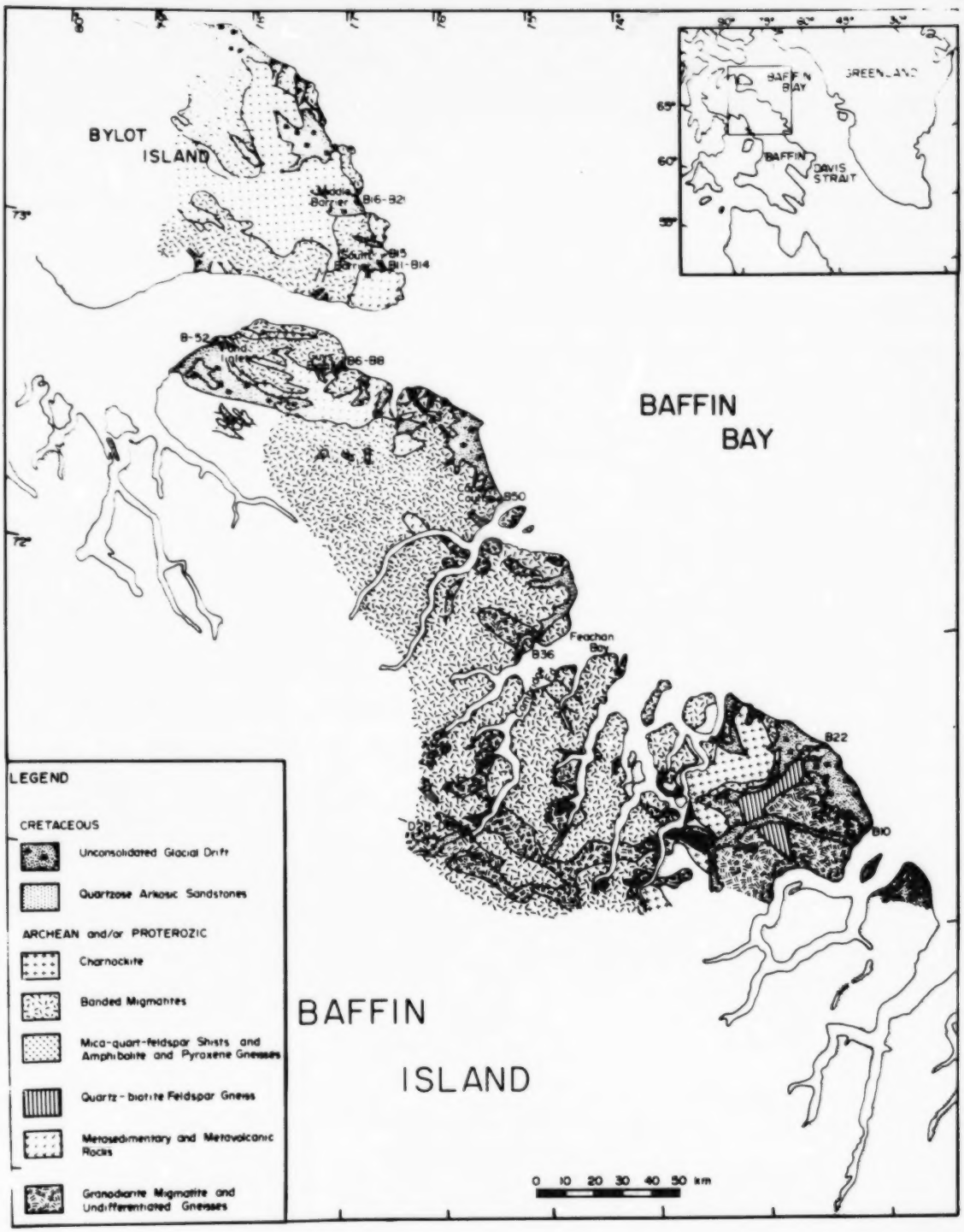


**Figure 2. General Geology**

## 2. GEOLOGY

Baffin Island is largely underlain by Precambrian acid crystalline rocks which form part of the Canadian Shield and Arctic Geological Provinces (Thorsteinsson and Tozer, 1970). Lower Paleozoic rocks occur locally at Cape Dyer, Rimrock Lake, western Bylot Island and dominate the shelf areas (McMillan, 1973). The Archean/Aphebian basement complex includes a heterogeneous assemblage of intricately folded granitic gneisses, metasediments and minor volcanics.

Within the present study area, the bedrock geology from Bylot Island to Scott Inlet has been mapped at a scale of 1:250,000 (Jackson and Davidson, 1975; Jackson 'et al.', 1975a, 1975b) (Figure 2). The bedrock is almost exclusively archean/phanerozoic in age and characterized by granulite to amphibolite metamorphic grades. The dominant lithologies are banded migmatites and charnockite; these rocks are composed of plagioclase, quartz, microcline and mafic minerals (including biotite, hornblende, hypersthene, clinopyroxene, garnet and magnetite) (Jackson and Davidson, 1975).

High grade iron ore deposits (hematite and megnetite) occur near the north-central end of Baffin Island in the Mary River Region (Jackson, 1966; Goss, 1966). Lead-zinc deposits occur in proterozoic sediments of northwestern Baffin Island (Jackson 'et al.', 1978).

## 3. QUATERNARY HISTORY

It has been demonstrated that the Late Wisconsin ice did not innundate the coastal regions nor the fjord headlands of eastern Baffin Island. The timing of the last ice innundation of eastern Baffin Island varies slightly with geographic location. Present evidence suggests a minmum date of pre-Middle Wisconsin (i.e. >50,000 years B.P., see review by Andrews and Ives, 1978).

Radiocarbon dates indicate that submergence began between 1500 and 2500 years B.P. (Miller 'et al.', 1980). Field evidence from central-southern Baffin Island (Pheasant and Andrews, 1973; England and Andrews, 1973; Andrews, 1980) suggests a relative sea level rise of approximately 1 m over the last 1000 years.

## 4. OCEANOGRAPHY

Water circulation in Baffin Bay is controlled both by the Baffin Land current, which moves cold water southward along the east coast of Baffin Island, and the West Greenland current which moves warm water northward along the west coast of Greenland. Mixing of waters from the two currents results in a counter-clockwise circulation pattern in Baffin Bay. Dunbar (1951) reports a maximum velocity of 40 cm/s for the Baffin Land current off northeastern Baffin Island. Collin and Dunbar (1964) summarize the general oceanography of Baffin Bay. Gilbert (1978, 1983) reviews factors and processes important in arctic fjord circulation. The mean tidal range at Clyde River is 0.9 m with a maximum spring tide of 1.4 m (Canadian Hydrographic Service, 1984). The tides are semi-diurnal to mixed semi-diurnal.

Some quantitative yet geographically remote wave data exist for wind generated currents off the east coast of Baffin Island. In an attempt to gain access to the local wave climate of the present study area, hindcasting techniques as described by Bretschneider (1958) were employed. Time series wind data from Broughton Island (Table 1) was used to calculate wave height, wave period and wave length for individual sample sites. Consideration was given to sea ice configuration (which controls fetch distances) and to fairweather versus storm conditions (Table II). The above technique was derived for deep water waves and thus imposes serious limitations when applied to nearshore waters. It does however, allow for an adequate first approximation.

Table I Wind Data, Broughton Island

storm conditions indicated by brackets

| Location | Fetch (km) | Direction | Maximum Duration (hrs) | Wind Speed (km/hr) |
|---|---|---|---|---|
| July 30 | | | | |
| .Middle Barrier | 444 | 360° | 230 (4) | 7 (121) |
| .South Barrier | 451 | 360° | 230 (4) | 7 (121) |
| August 27 | | | | |
| .Middle Barrier | 469 | 360° | 240 (3) | 8 (56) |
| .South Barrier | 484 | " | " " | " |
| .Feachan Bay | 691 | " | " " | " |
| .Cape Adair | 731 | " | " " | " |
| .Scott Inlet | 637 | " | " " | " |
| .Kogalu River | 680 | " | " " | " |
| September 24 | | | | |
| .Middle Barrier | 163 | 315° | 250 (10) | 9 (82) |
| .South Barrier | 178 | " | " | " |
| .Feachan Bay | 301 | " | " | " |
| .Cape Adair | 429 | " | " " | " |
| .Scott Inlet | 498 | " | " " | " |
| .Kogalu River | 560 | " | " " | " |
| .Cape Aston | 646 | " | " " | " |
| .Cape Hewitt | 672 | " | " " | " |

## Table II Wave Statistics

H = wave height, T = wave period, c = wind speed,
L = wave length, OV = orbital velocity

| Location | Fairweather | | | |
|---|---|---|---|---|
| | H(m) | T(sec) | C(cm/sec) | L(m) |
| July 30 | | | | |
| Middle Barrier | .11 | 1.5 | 2.3 | 3.5 |
| South Barrier | .11 | 1.5 | 2.3 | 3.4 |
| August 27 | | | | |
| Middle Barrrier | .14 | 1.7 | 2.6 | 4.4 |
| South Barrier | .14 | 1.7 | 2.6 | 4.4 |
| Feachan Bay | .14 | 1.7 | 2.6 | 4.5 |
| Cape Adair | .14 | 1.7 | 2.6 | 4.5 |
| Scott Inlet | .14 | 1.7 | 2.6 | 4.4 |
| Kogalu River | .14 | 1.7 | 2.6 | 4.5 |
| September 24 | | | | |
| Middle Barrier | .18 | 1.8 | 2.8 | 5.1 |
| South Barrier | .18 | 1.8 | 2.8 | 5.1 |
| Feachan Bay | .18 | 1.9 | 2.9 | 5.4 |
| Cape Adair | .18 | 1.9 | 2.9 | 5.5 |
| Scott Inlet | .18 | 1.9 | 2.9 | 5.5 |
| Kogalu River | .18 | 1.9 | 2.9 | 5.6 |
| Cape Aston | .18 | 1.9 | 2.0 | 5.6 |
| Cape Hewitt | .18 | 1.9 | 2.9 | 5.6 |

| Location | Storm | | | |
|---|---|---|---|---|
| | H | T | C | L |
| July 30 | | | | |
| Middle Barrier | 12.4 | 14 | 21.8 | 305.6 |
| South Barrier | 12.5 | 14 | 22 | 307 |
| August 27 | | | | |
| Middle Barrrier | 4.6 | 8.6 | 13 | 115 |
| South Barrier | 4.6 | 8.6 | 13·5 | 116 |
| Feachan Bay | 5.1 | 9.1 | 14.2 | 129 |
| Cape Adair | 5.1 | 9.1 | 14 | 131 |
| Scott Inlet | 5.0 | 9.0 | 14.0 | 126 |
| Kogalu River | 5.1 | 9.1 | 14 | 128 |
| September 24 | | | | |
| Middle Barrier | 5.2 | 9.1 | 14 | 128 |
| South Barrier | 5.4 | 9.2 | 14 | 133 |
| Feachan Bay | 6.6 | 10.2 | 16.0 | 163 |
| Cape Adair | 7.5 | 10.9 | 17 | 185 |
| Scott Inlet | 7.9 | 11.2 | 17.5 | 196 |
| Kogalu River | 8.2 | 11.4 | 18 | 204 |
| Cape Aston | 8.6 | 11.7 | 18.3 | 214 |
| Cape Hewitt | 8.7 | 11.8 | 18 | 217 |

## 5. SEA ICE

The Baffin Land current initiates ice formation in early to late October. The freeze-up period is then approximately one month, after which time most of eastern Baffin Bay is covered by 100 to 150 cm of thick pack ice. Spring thaw begins in mid-June and continues until early September (Markham, 1984). Figure 3 illustrates the pattern of ice thaw within the study area. The duration of the open water season varies with each sample site but is generally much less than 100 days per year.

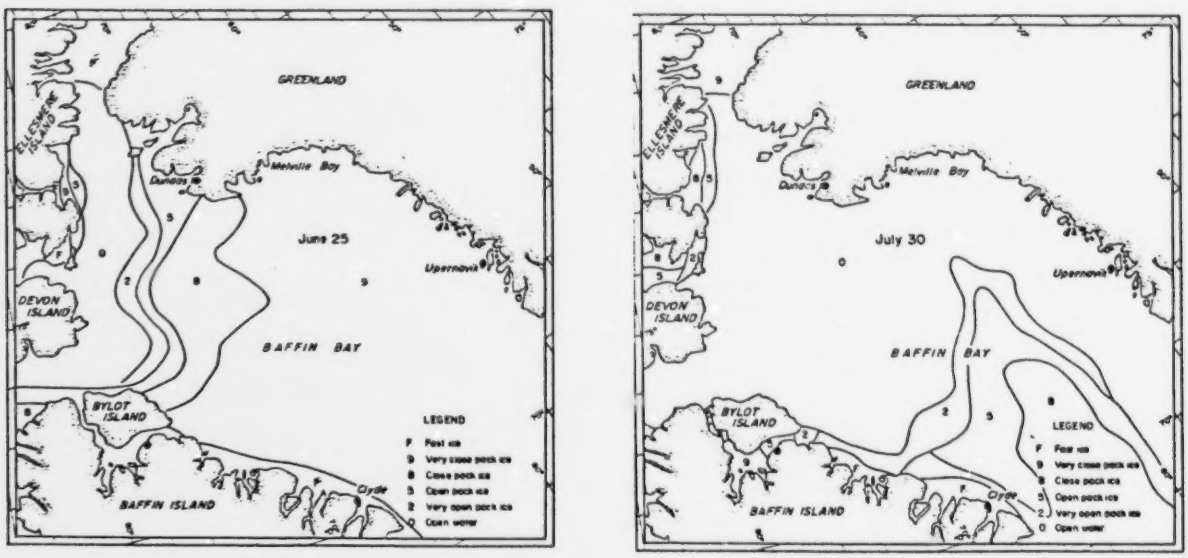


Figure 3. Sea Ice Extent - Modified from Maxwell (1982)

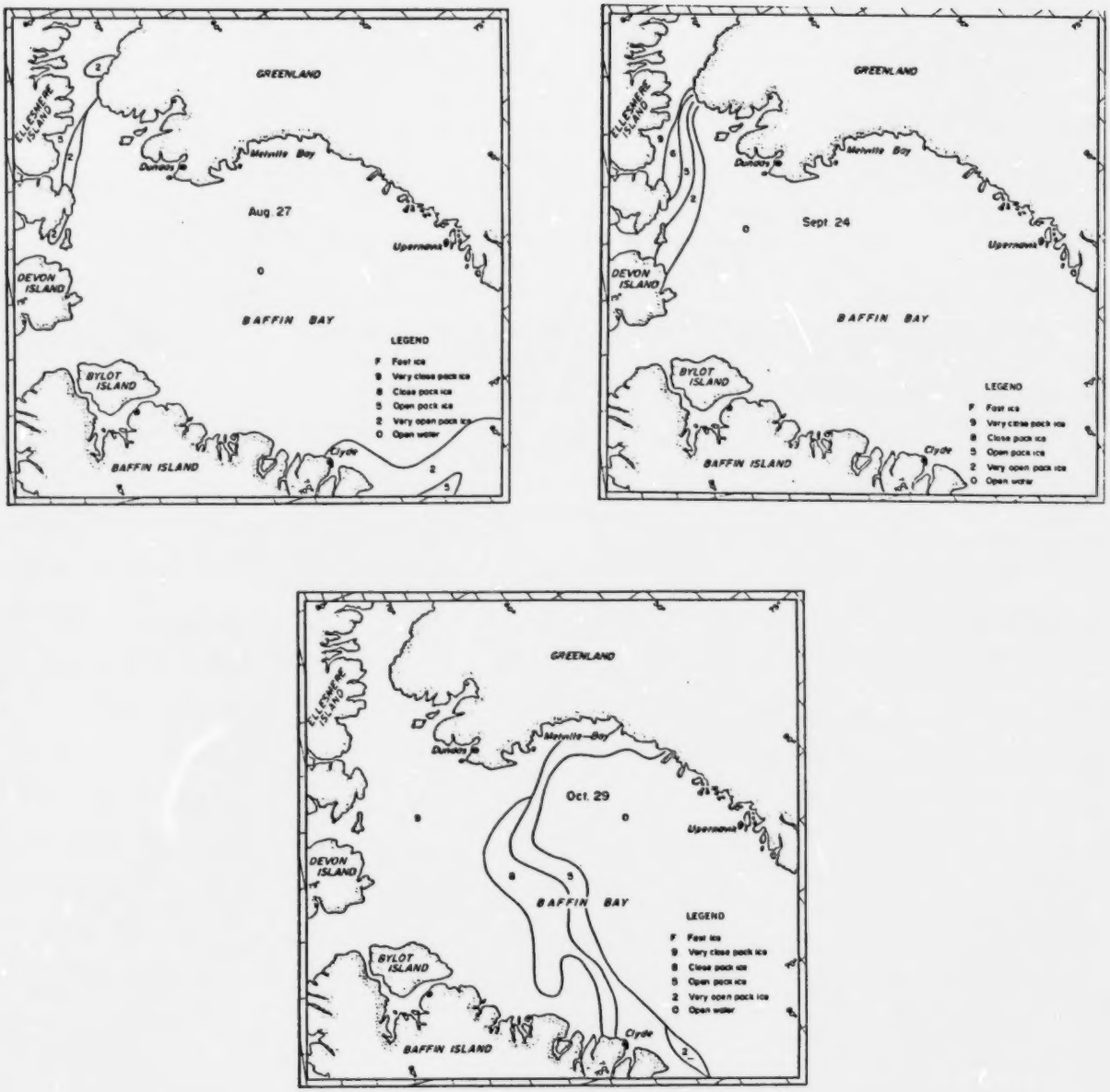


Figure 3. Continued

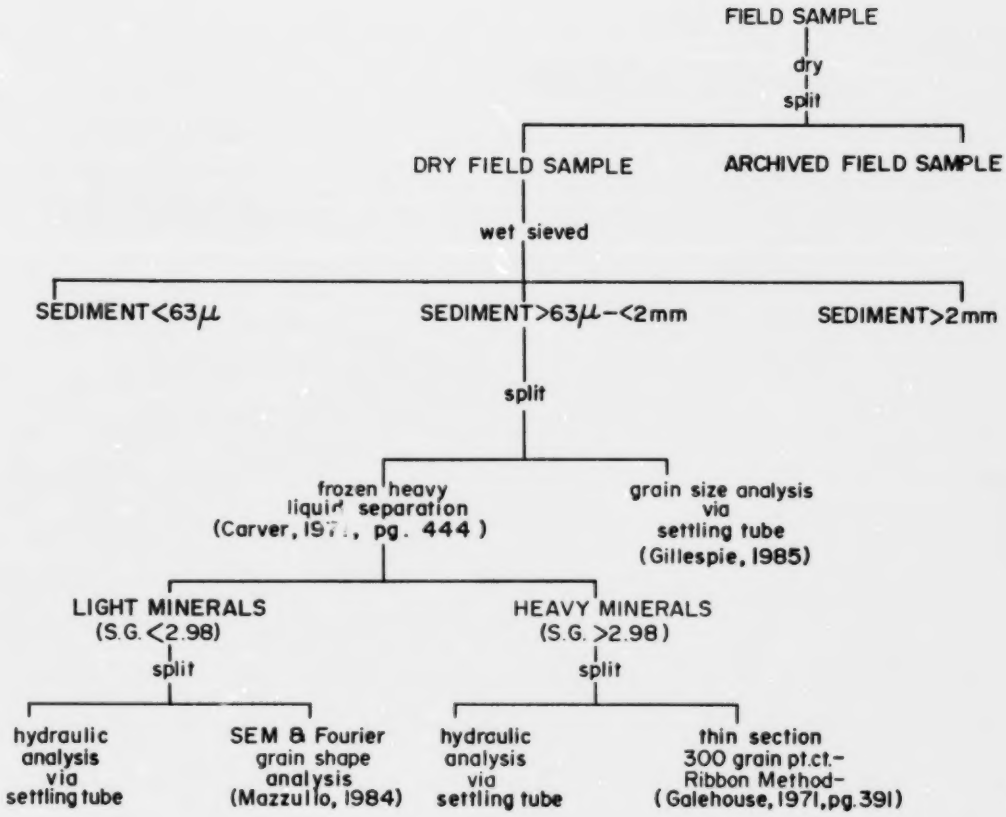


Figure 4. Analytical Methodologies

(see section 6)

## 6. SAMPLING AND ANALYTICAL TECHNIQUES

An Eckman dredge and Van Veen grab sampler were used to collect surface samples (upper 2-3 cm) from within the prodelta environment. Surface and trench samples from Cambridge and McBeth deltas (sandurs) and coastal beaches were collected using a hand trowel. Representative samples from 4 facies (raised marine, fluvial, aeolian and intertidal-supratidal) within each delta complex were collected. In sampling trenches every effort was made not to cross-cut sediment units or allow contamination of the sample by adjacent layers. A regional sample location map is provided (Figure 1), along with large scale site specific maps (Appendix A).

The analytical steps involved in the processing of each sample are illustrated in Figure 4 (note references on the figure for procedural information). All analyses were restricted to the sand fractions (> 63 $\mu$m to < 2 mm). Heavy mineral separation introduces an error of approximately ±10%, point counting an error of ±3% (Galehouse, 1971).

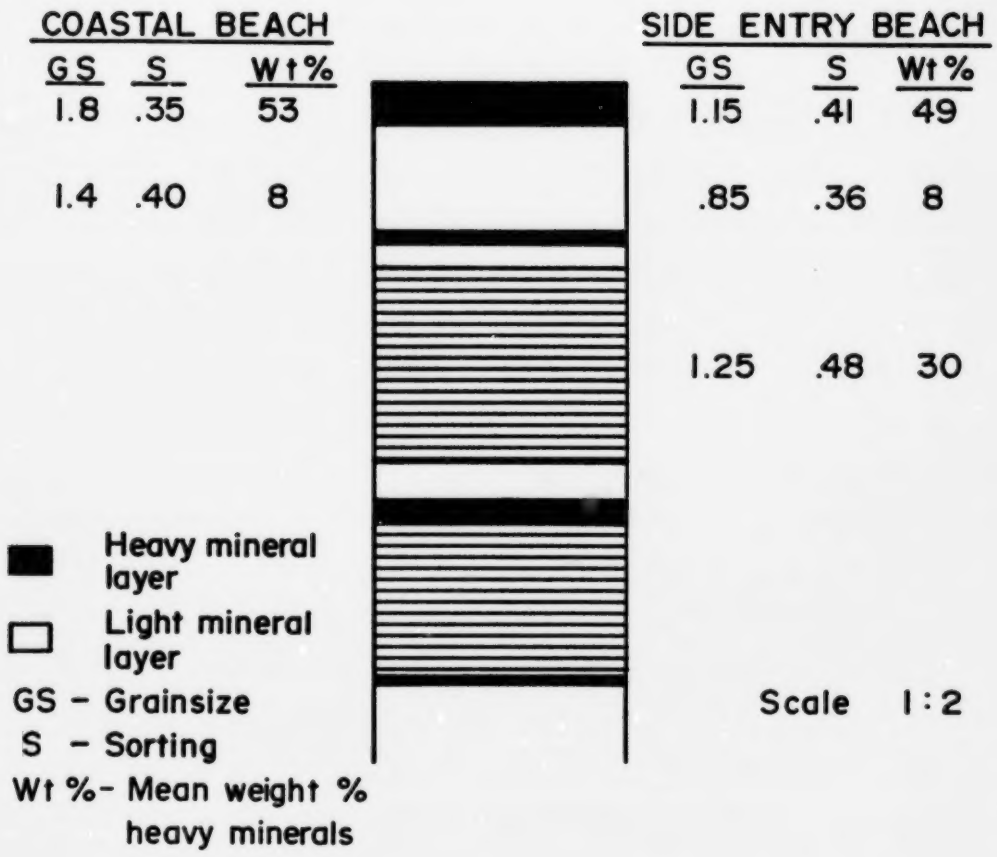


Figure 5. Beach Trench Stratigraphy

(see section 7.1.1)

## 7. DATA PRESENTATION

### 7.1 Sand Texture

Moment statistics as described by Folk (1954) were used to evaluate the textural characteristics of sand within the nearshore environments of eastern Baffin Island. Field descriptions and grain size statistics for all samples are listed in Appendix B.

#### 7.1.1 Beaches

On average, the mean grain size of the sands within the coastal beaches of eastern Baffin Island is 1.5 ø (medium sands), the average sorting coefficient 0.4 (well sorted). Figure 5 illustrates a generalized stratigraphy of a beach trench and corresponding moment statistics for each layer. Both the heavy mineral rich sands and the 'clean' sands are well sorted; the clean sands are slightly coarser than their heavy mineral counterparts. A sorting mechanism (whether it be aeolian, marine, fluvial or some combination thereof) operative within the beach environment has been effective in the segregation of heavy and light minerals. Regionally, the textural characteristics of sands within the coastal beach systems are similar (Figure 6); low sample density may mask apparent trends however.

The side-entry beach (i.e. a beach fronting a major ice lobe) in McBeth fjord is characterized by an average mean grain size of 1.0 ø and a mean sorting of 0.4. In comparison, this beach is slightly coarser grained than the coastal beaches yet similar in stratigraphic structure and relative textural parameters (Figure 5).

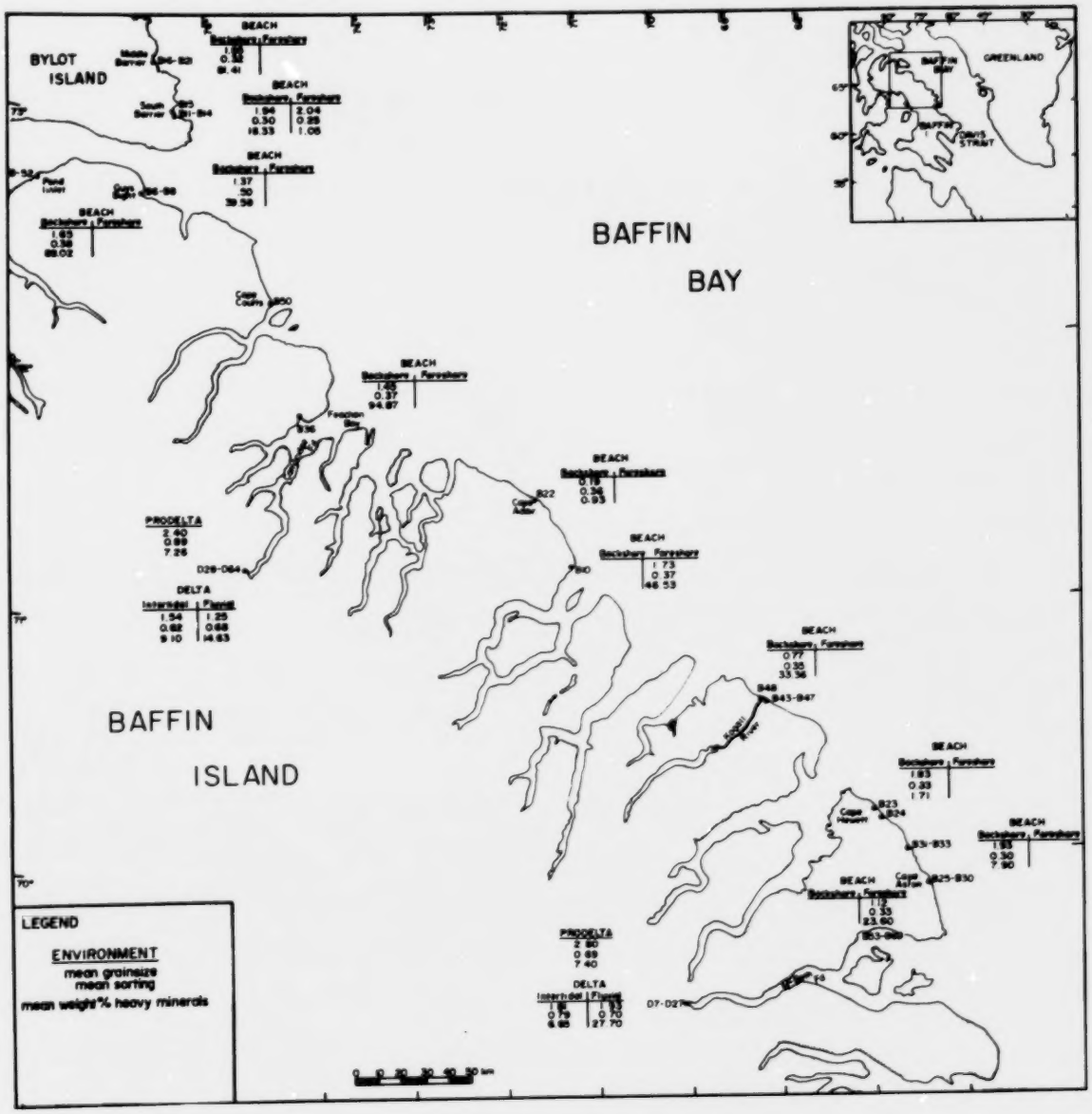


Figure 6. Grain size statistics and heavy mineral abundances, eastern Baffin Island

7.1.2 Delta/Prodelta

The delta (sandur) complex is divided into 4 facies for convenience of comparison: raised marine sediments, fluvial sediments, intertidal-supratidal sediments and aeolian sediments. Moment statistics for each facies within McBeth and Cambridge delta are listed in Table III. The sand texture for both deltas is similar and can be defined as moderately well sorted medium sand. The sands in the fluvial and raised marine sequences are slightly finer- grained and less sorted than the intertidal-supratidal and aeolian sediments.

The mean grain size of sands within Cambridge prodelta is 2.4 ø, the mean sorting coefficient 0.9. McBeth prodelta is characterized by a mean grain size of 2.8 ø and a sorting coefficient of 0.7.

Table III

Grain size statistics and heavy mineral abundances, McBeth and Cambridge delta, eastern Baffin Island (a = mean grain size, b = mean sorting, c = mean weight % heavy minerals).

| | Raised Marine | | | Fluvial | | | Intertidal-Supratidal | | | Aeolian | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | a | b | c | a | b | c | a | b | c | a | b | c |
| McBeth | 1.98 | .64 | 4.39 | 1.93 | .73 | 27.72 | 1.52 | .63 | 4.53 | 1.50 | .63 | 3.65 |
| Cambridge | 1.79 | .71 | 9.20 | 1.26 | .74 | 14.63 | 1.46 | .61 | 8.38 | 1.65 | .56 | 6.25 |

## 7.2. Heavy Minerals

Raw data on heavy mineralogy and abundances are listed in Appendix C.

### 7.2.1 Heavy Mineral Abundance

Beaches

The mean weight % heavy minerals for the coastal and side-entry beaches is 30% and 28% respectively. Figure 5 illustrates the variation in mean weight % heavy minerals for clean sands and heavy mineral rich sands. The mean weight % heavy minerals in surface samples from each location is illustrated in Figure 6. Large regional variations occur; Middle Barrier, Pond Inlet and Scott Inlet contain > 80 weight % heavies while areas such as Cape Adair, Cape Aston and Cape Hewitt contain only 1-8 weight % heavy minerals. The McBeth side-entry beach averages 24 weight % heavy minerals.

Delta/Prodelta

The mean weight % of heavy minerals within the 4 facies of Cambridge and McBeth deltas is listed in Table III. With the exception of fluvial sediments, Cambridge is characterized by a greater abundance of heavy minerals. For both deltas, the greatest abundance of heavy minerals occurs within the fluvial sediments followed by the raised marine, intertidal-supratidal and aeolian sediments respectively.

Cambridge prodelta averages 8.2 weight % heavy minerals, McBeth 7.4 weight % heavy minerals.

### 7.2.2 Heavy Mineral Distribution

#### Beaches

Heavy mineral assemblages within the beaches of eastern Baffin Island include garnet, opaques, pyroxene, amphibole and oblivine with minor tourmaline, sphene, zircon, epidote, hematite staurolite and rutile (see Appendix A). Figure 7 illustrates the mean number % of individual mineral species within the coastal and side-entry beach systems.

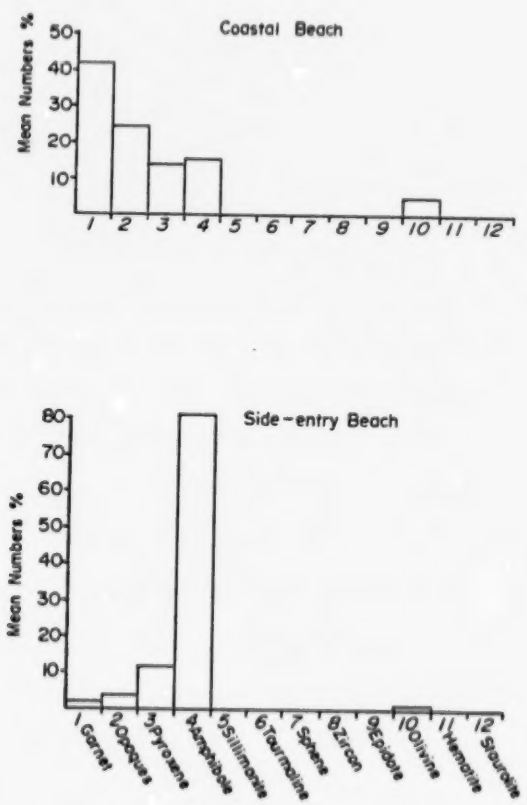


Figure 7. Mean number % of individual mineral species within coastal and side-entry beaches eastern Baffin Island

The heavy mineralogy of beach sand varies with geographic location (Figure 8). Samples from the northern end of the study area (i.e. Middle Barrier, South Barrier, Pond Inlet and Guys Bight) are richest in garnet, pyroxene and opaques. The remaining, more southerly sample sites, are dominated by opaques and amphibole. Anomalous concentrations of olivine occur on Bylot Island and are most prominent at Middle Barrier.

The heavy mineralogy of the side-entry beach in McBeth fjord is dominantly amphibole (hornblende) with variable amounts of pyroxene, opaques and garnet.

Delta/Prodelta

Figure 9 summarizes the mean number % of individual mineral species within the delta/prodelta sediments of Cambridge and McBeth fjords. Within McBeth, the delta sediments contain significant garnet, tourmaline and opaques with variable amounts of amphibole and pyroxene. Minor amounts of sphene, zircon, epidote, olivine and rutile are also present. Sillimanite and hematite are restricted in occurrence to the McBeth delta/prodelta sediments.

A predominance of amphibole and opaques characterize the delta sediments of Cambridge fjord. Tourmaline, sphene, epidote and pyroxene are also present with minor to trace amounts of garnet, zircon, olivine and stuarolite.

Tourmaline is the most abundant heavy mineral within the prodelta sediments of the McBeth fjord. Tourmaline is followed in abundance by opaques, pyroxene and garnet. Sillimanite and

hematite are present with minor zircon and epidote. Cambridge prodelta sediments are characterized by high abundances of amphibole and opaques. Lesser amounts of garnet, tourmaline, sphene, zircon, epidote and hematite are also present.

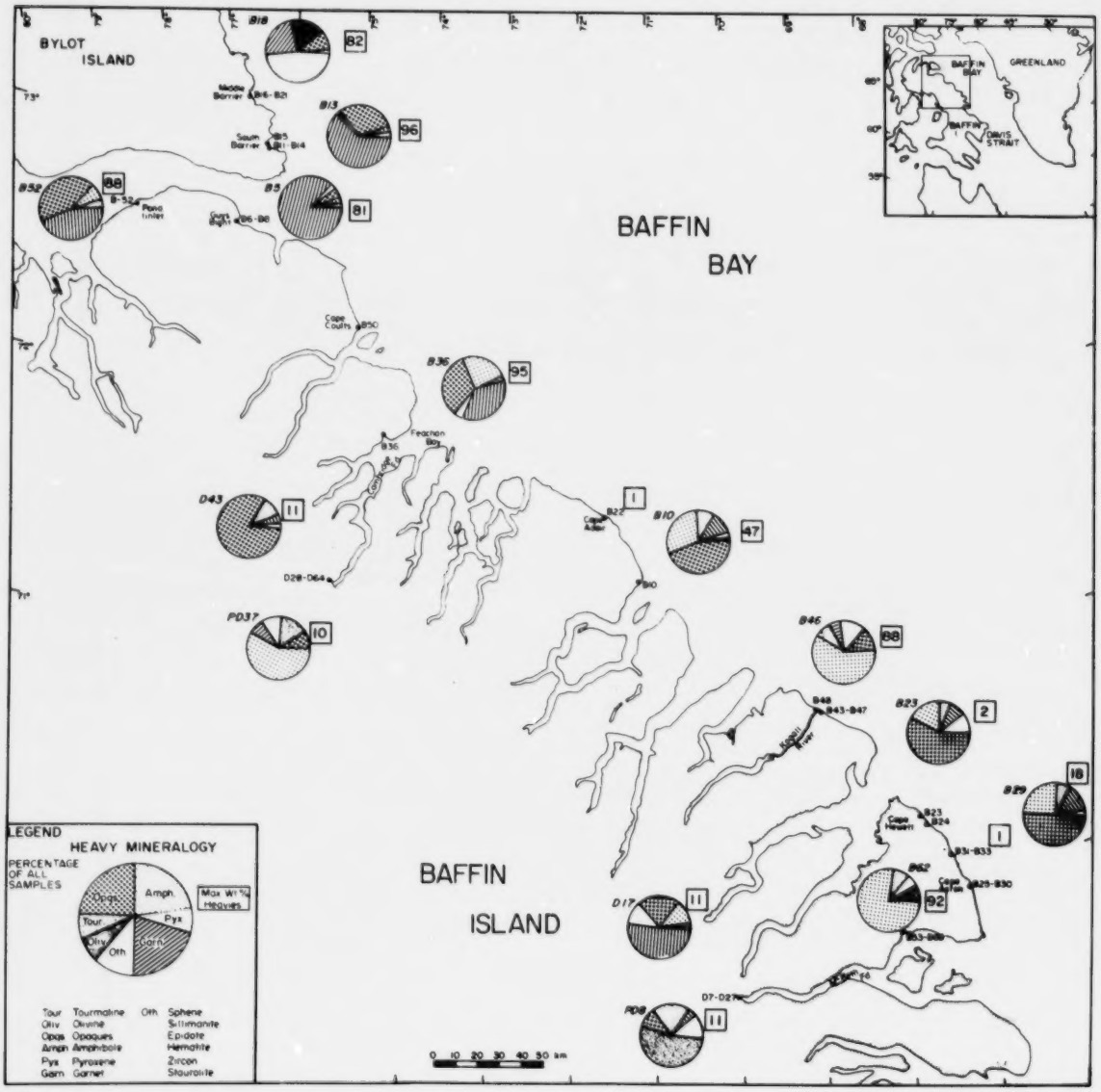


Figure 8. Heavy Mineral Distribution

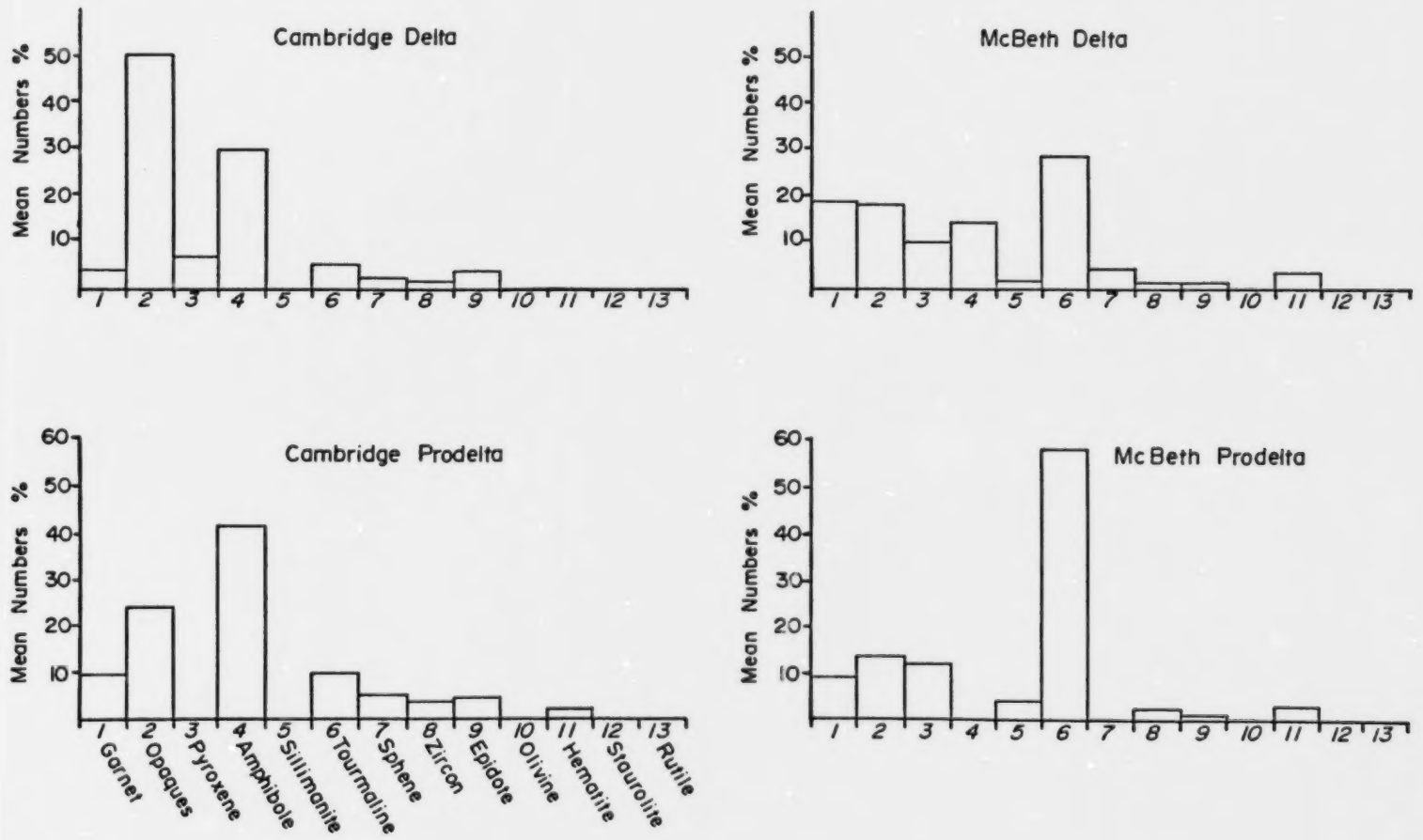


Figure 9 Mean number % of individual mineral species within the delta and prodella environments of Cambridge and McBeth fjord.

## 7.3 Hydraulic Equivalence

The concept of hydraulic equivalence, originally defined by Rubey (1933) states that grains of different densities, if deposited together, should have the same settling velocities. Divergence from true hydraulic equivalence may be the result of differential entrainment, the absence of minerals of a given size from the sediment population chemical decomposition and/or sampling error.

A preliminary evaluation of hydraulic equivalence is provided here by comparing the size frequency distributions of the light versus heavy sand fractions of specific samples. It is assumed that the light fraction has a specific gravity of 2.65 and the heavy fraction a specific gravity of 3.50. Representative samples from each environment were analysed (Figure 10).

Rubey (1933), using Stoke's law and the principle of settling velocities, defined a relationship whereby when two mineral grains are in hydraulic equivalence, the diameter of the heavy grain (dh) is calculated as a fraction of the diameter of the light grain (dl). Therefore, where dh = .81 dl, the diameter of the heavy mineral grain should be .81 x the diameter of the light mineral grain. For the purpose of the present study, the actual diameters of the heavy and light grains were obtained from the respective size frequency distributions and compared to those calculated by Rubey's equation (Table IV).

Although local variation is evident, the relative closeness of theoretical versus actual grain diameters is indicative of a

generalized hydraulically equivalent sediment package for the nearshore environments of eastern Baffin Island.

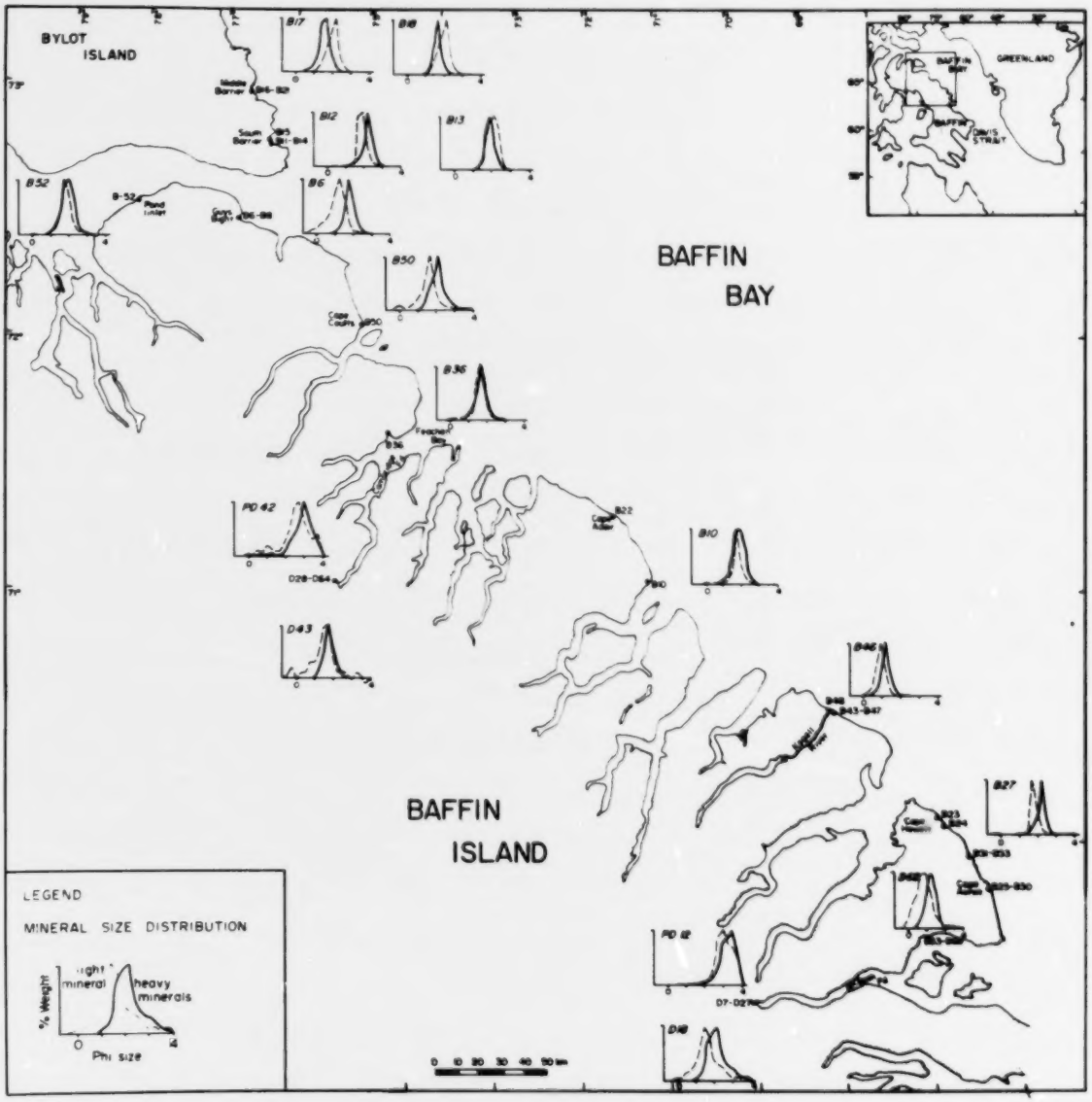


Figure 10. Heavy and Light Mineral Distribution

## Table IV

## Actual Versus Theoretical Hydraulic Equivalence

| SAMPLE NUMBER | | MEAN GRAIN SIZE ø | MEAN SORTING | HYDRAULIC EQUIVALENCE |
|---|---|---|---|---|
| B 6 | S.G. < 2.98 | 1.23 | 1.97 | Rubey's: dh = .81 dl |
| | S.G. > 2.98 | 0.51 | 0.12 | Actual: dh = .62 dl |
| B 10 | S.G. < 2.98 | 1.92 | 2.00 | Rubey's: dh = .81 dl |
| | S.G. > 2.98 | 0.22 | 0.32 | Actual: dh = .95 dl |
| B 13 | S.G. < 2.98 | 2.06 | 0.27 | Rubey's: dh = .81 dl |
| | S.G. > 2.98 | 2.20 | 0.11 | Actual: dh = .94 dl |
| B 17 | S.G. < 2.98 | 1.70 | 0.35 | Rubey's: dh = .81 dl |
| | S.G. > 2.98 | 2.20 | 0.27 | Actual: dh = .77 dl |
| B 18 | S.G. < 2.98 | 1.85 | 0.30 | Rubey's: dh = .81 dl |
| | S.G. > 2.98 | 2.18 | 0.21 | Actual: dh = .85 dl |
| B 27 | S.G. < 2.98 | 1.94 | 0.20 | Rubey's: dh = .81 dl |
| | S.G. > 2.98 | 2.35 | 0.27 | Actual: dh = .83 dl |
| B 36 | S.G. < 2.98 | 1.78 | 0.36 | Rubey's: dh = .81 dl |
| | S.G. > 2.98 | 1.84 | 0.31 | Actual: dh = .97 dl |
| B 46 | S.G. < 2.98 | 1.08 | 0.38 | Rubey's: dh = .81 dl |
| | S.G. > 2.98 | 1.40 | 0.26 | Actual: dh = .78 dl |
| B 50 | S.G. < 2.98 | 1.73 | 0.52 | Rubey's: dh = .81 dl |
| | S.G. > 2.98 | 2.27 | 0.43 | Actual: dh = .76 dl |
| B 52 | S.G. < 2.98 | 1.99 | 0.31 | Rubey's: dh = .81 dl |
| | S.G. > 2.98 | 2.07 | 0.32 | Actual: dh = .96 dl |
| B 68 | S.G. < 2.98 | 1.01 | 0.50 | Rubey's: dh = .81 dl |
| | S.G. > 2.98 | 1.40 | 0.30 | Actual: dh = .72 dl |
| D 18 | S.G. < 2.98 | 1.80 | 0.73 | Rubey's: dh = .81 dl |
| | S.G. > 2.98 | 2.31 | 0.51 | Actual: dh = .78 dl |
| D 43 | S.G. < 2.98 | 1.55 | 0.72 | Rubey's: dh = .81 dl |
| | S.G. > 2.98 | 1.97 | 0.28 | Actual: dh = .79 dl |
| PD12 | S.G. < 2.98 | 3.25 | 0.38 | Rubey's: dh = .81 dl |
| | S.G. > 2.98 | 3.41 | 0.52 | Actual: dh = .95 dl |
| PD42 | S.G. < 2.98 | 2.72 | 0.69 | Rubey's: dh = .81 dl |
| | S.G. > 2.98 | 3.13 | 0.51 | Actual: dh = .87 dl |

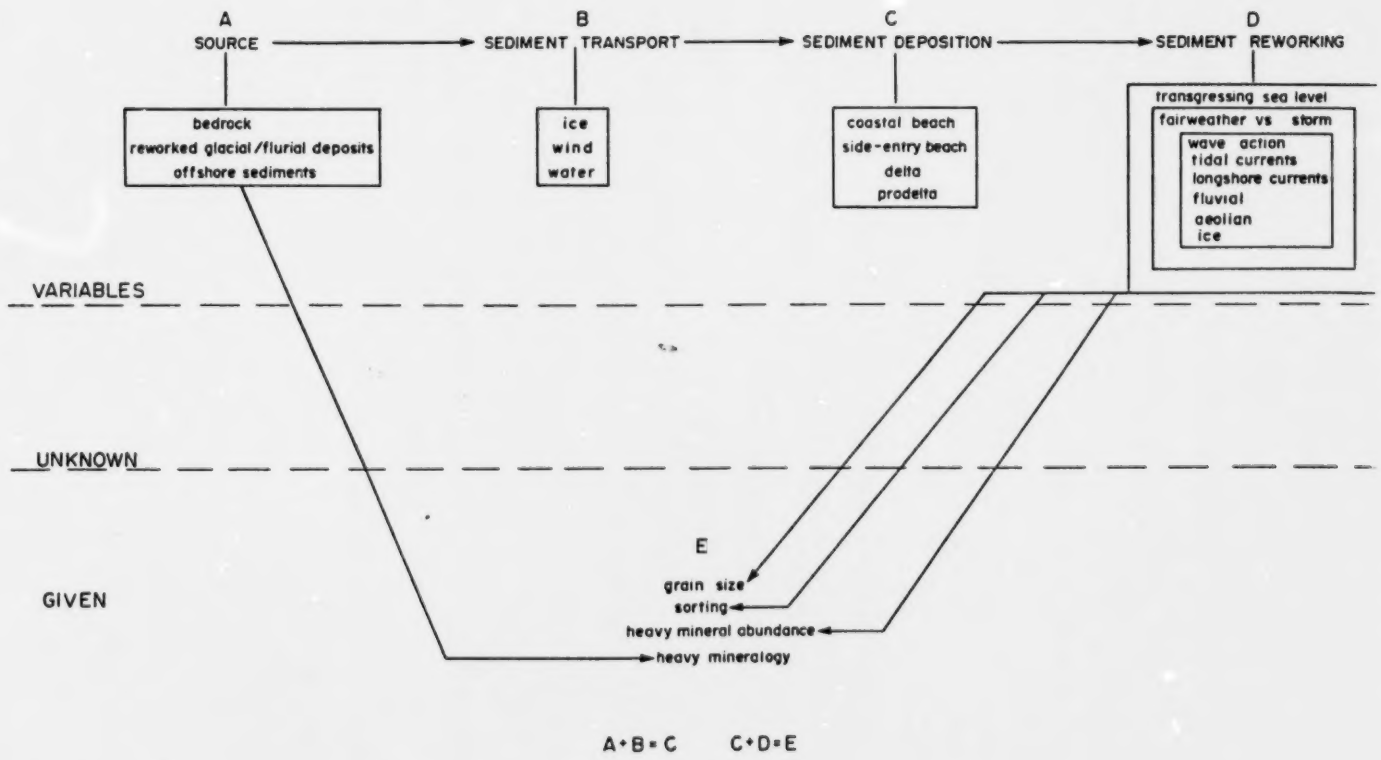


Figure 11 Generalized Sedimentation Model.

## 8. DISCUSSION

A tentative sedimentation model for the nearshore environments of eastern Baffin Island is illustrated in Figure 11. A series of variables included in factors A, B, C and D interact in site specific ways to produce sediments with known textural and mineralogical characteristics (defined in Section 7). One primary objective of the present study is to determine the relative contribution of each variable to the definition of sediment type. An assessment of those areas, most favourable for placer type deposits within the nearshore zone of eastern Baffin Island, may then be made. Interpretive discussions of the sedimentation model is at present limited to 'source'.

### 8.1 Source

Previous studies on Baffin Island (e.g. Miller 'et al.', 1980; Church, 1972; Kranck, 1964) found that littoral zone sediments are derived (in order of decreasing importance) from: a) erosion and redeposition of Lake Wisconsin glacial deposits, b) bedrock weathering, and c) present glacier debris. The role of storm waves, ice and a transgressive sea level in the onshore transportation of sediment on Baffin Island has received little attention yet these forces remain viable transport mechanisms.

For the purpose of the present study, heavy mineralogy is used to gain access to primary bedrock sources for the coastal sediments of eastern Baffin Island. As eastern Baffin Island is largely underlain by acid crystalline rocks, local variations in coastal sand mineralogy are difficult to interpret in the context

of bedrock source. Regional variations in sand mineralogy do however appear to be source related; metavolcanics and charnockites are most prominent in the northern section of the study area (Figure 2) and are characterized by pyroxene (hyprshene) and garnet (Jackson and Davidson, 1975). These minerals also dominate the heavy mineral suite at Middle Barrier, South Barrier, Pond Inlet, and Guys Bight (i.e. all the northern sample stations, Figure 8). The coastal sands collected in the central-southern study area are dominated by opaques and amphibole; these minerals are also common constituents of the migmatites and gneisses which characterize the inland geology. Regional variation in heavy mineral distribution is therefore source related. Similar conclusions have been reached by Kranck (1964) in Exeter Bay, and by Buckley (1971) in Lancaster Sound.

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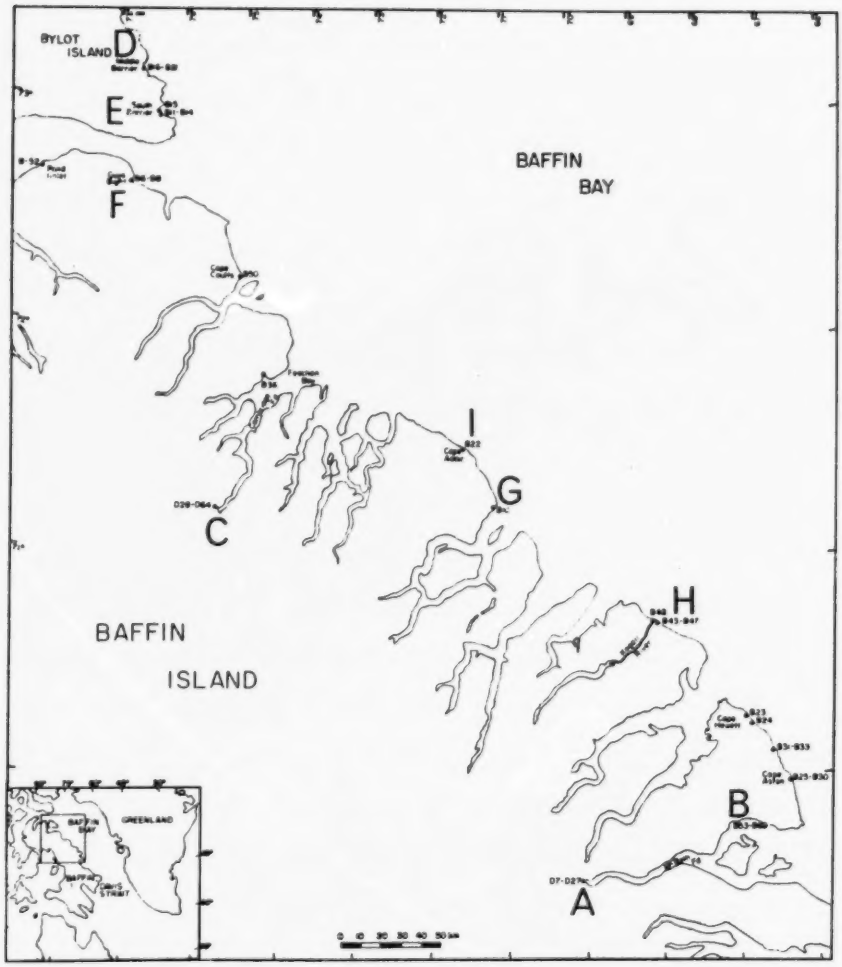
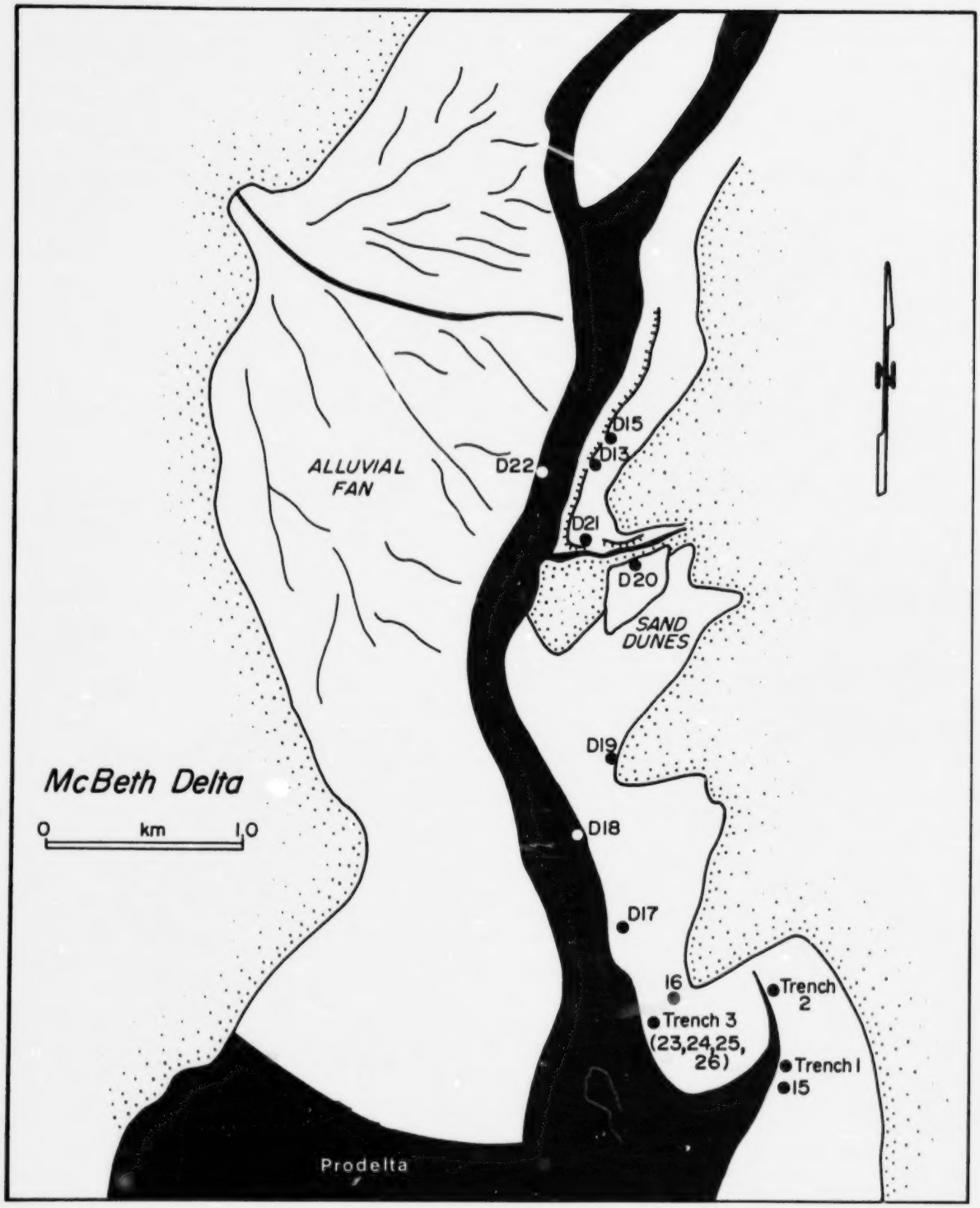
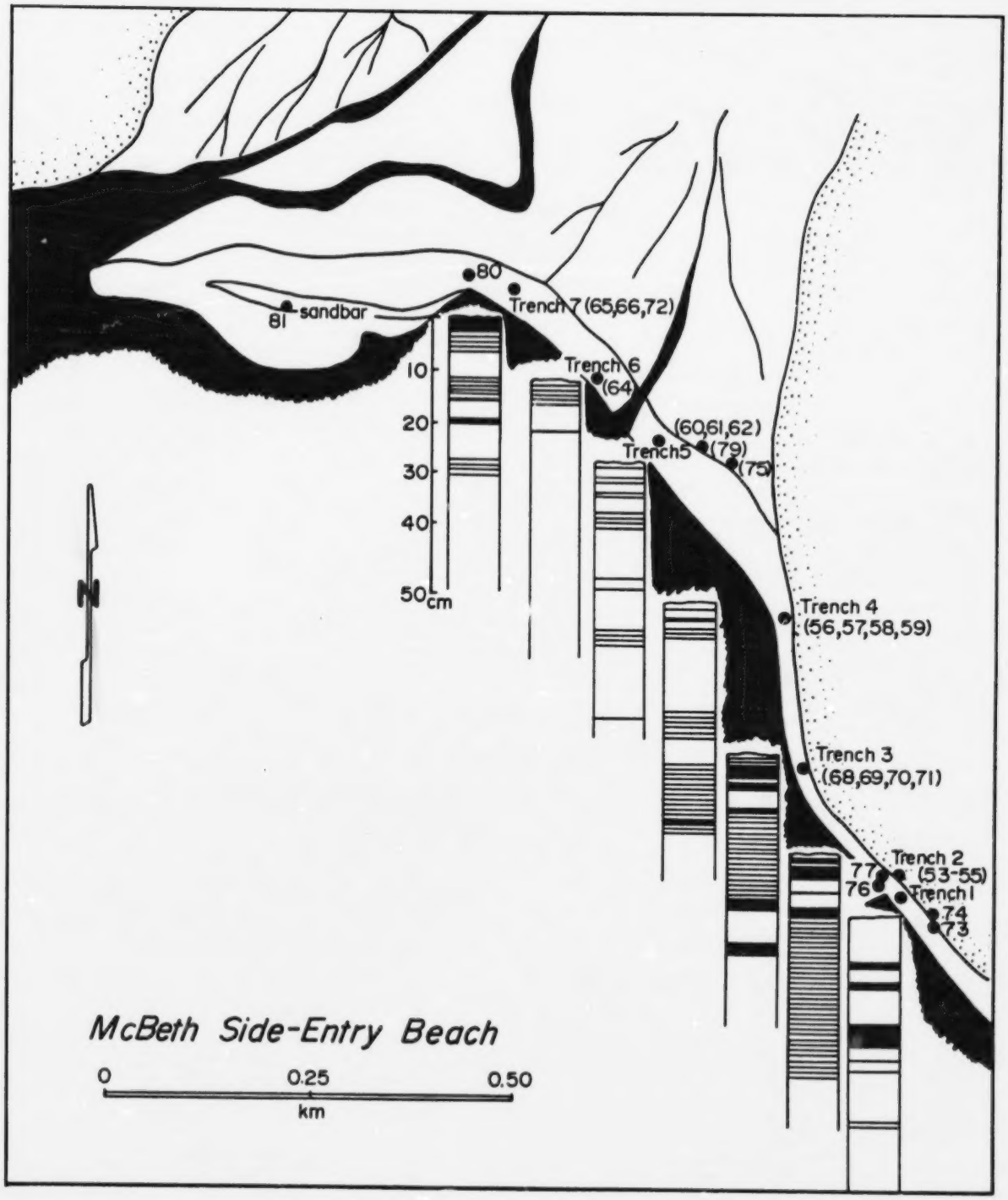
## APPENDIX A

## Large Scale Site Specific Maps

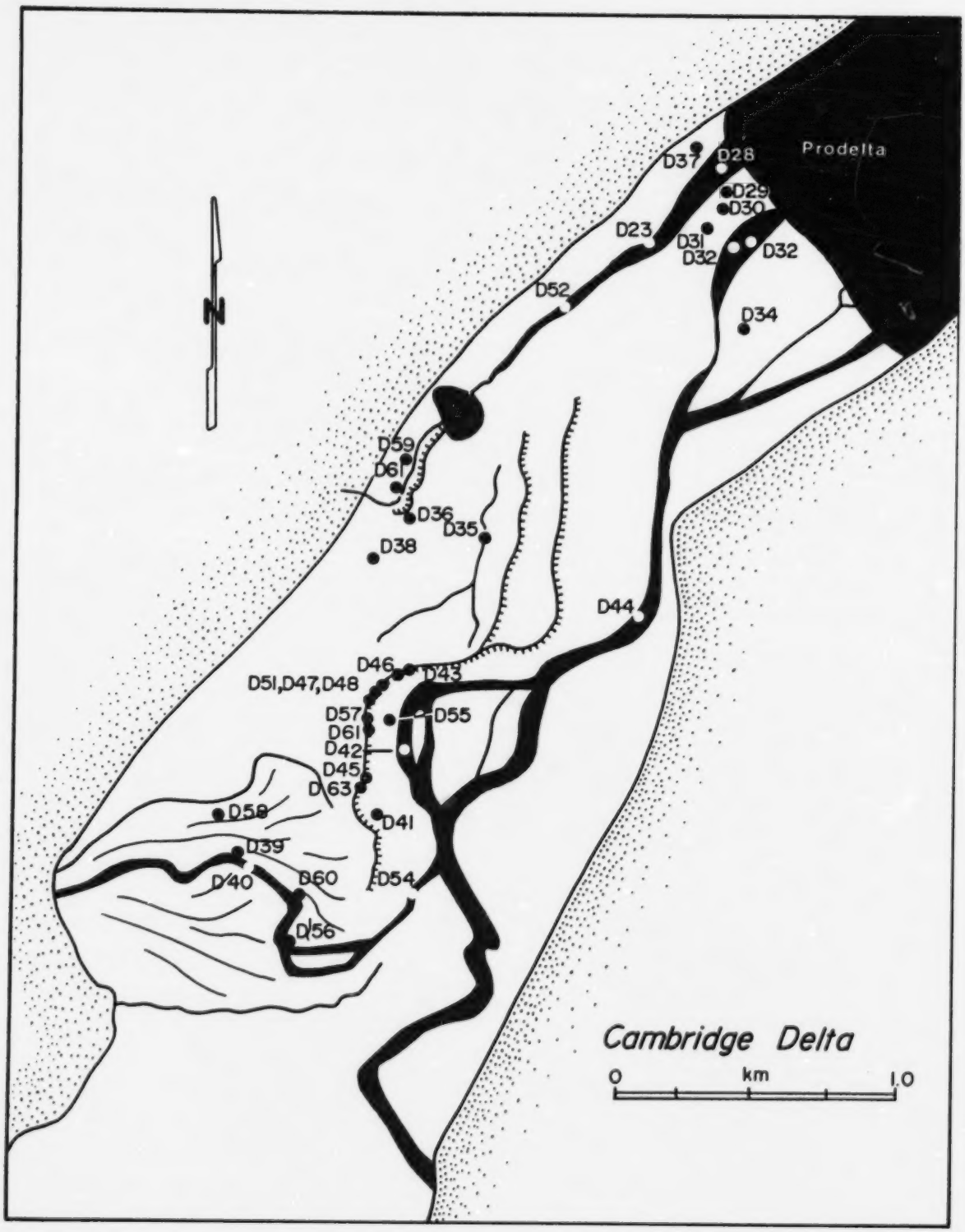




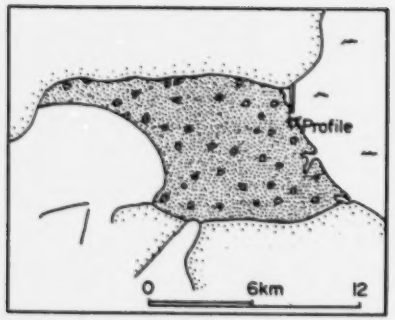

Sample location map McBeth Delta (see p. 31, A)

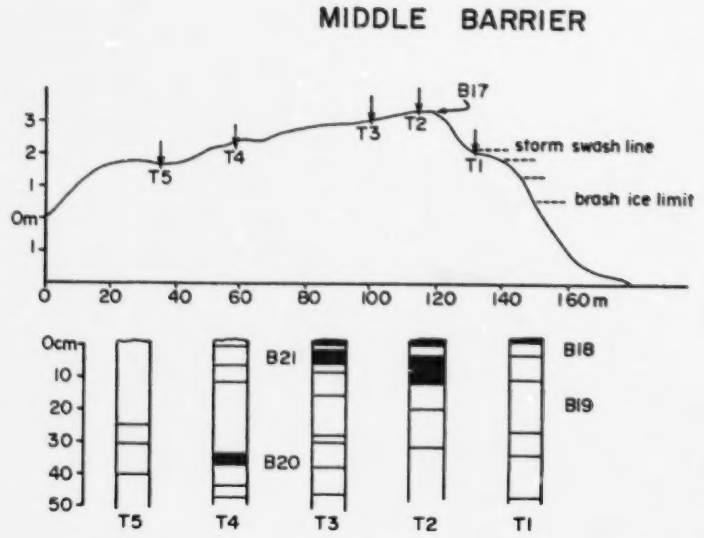


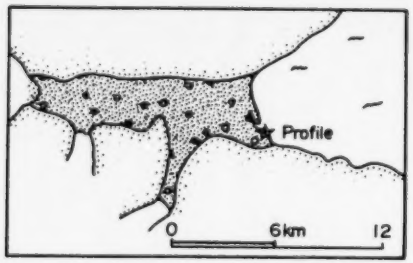

Sample location and trench stratigraphy, McBeth side entry beach (see p. 31, B)

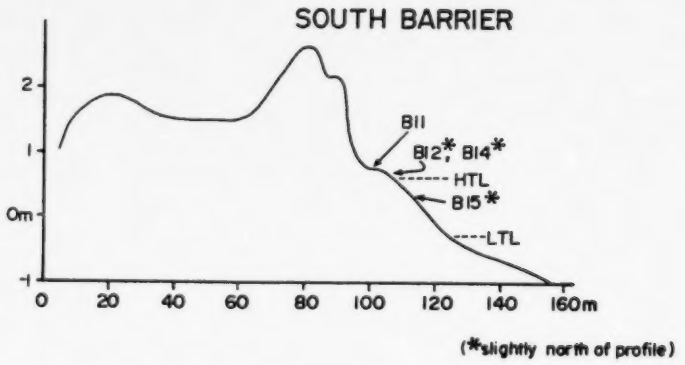



Sample location map, Cambridge Delta (see p. 31, C)

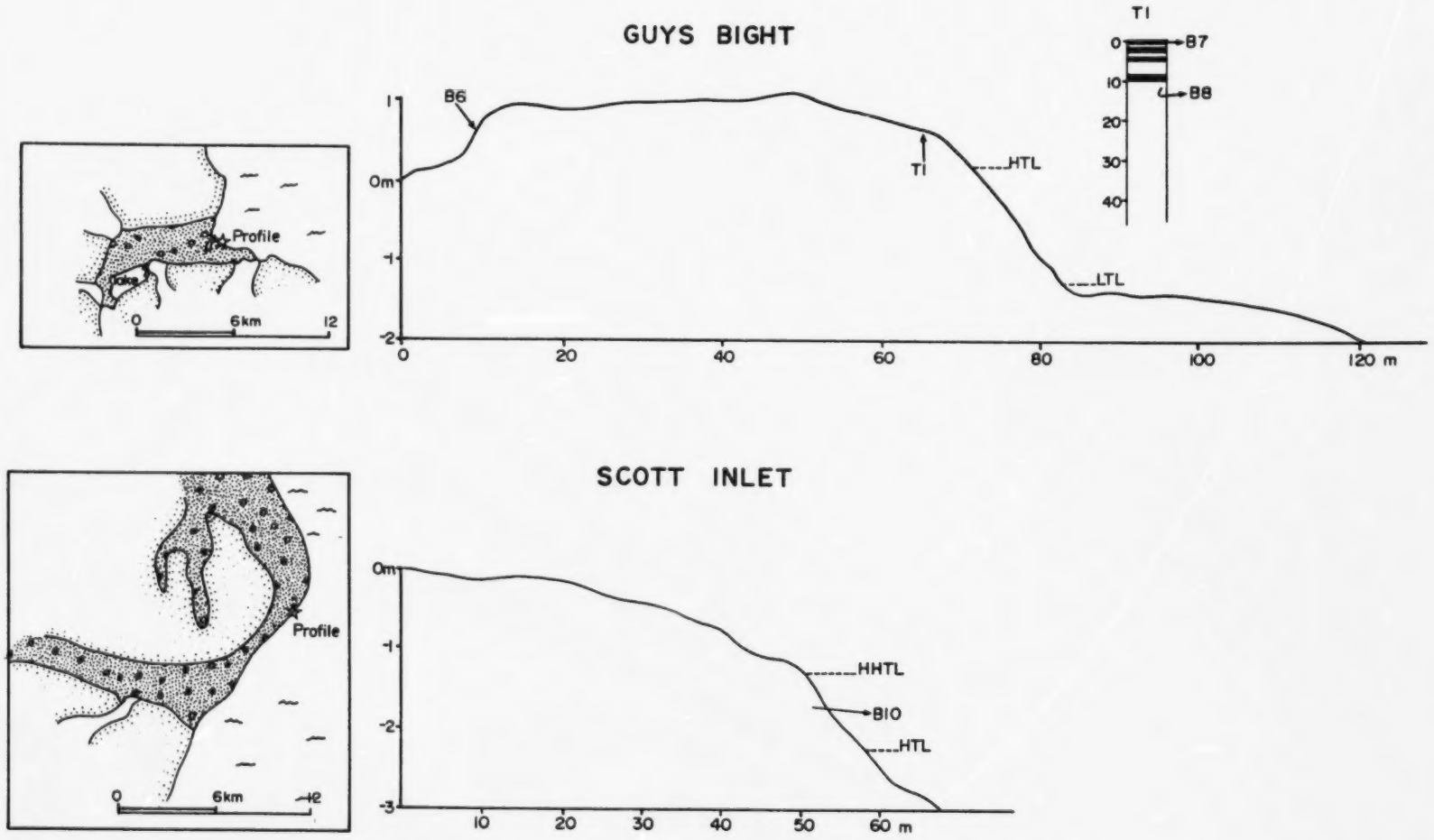


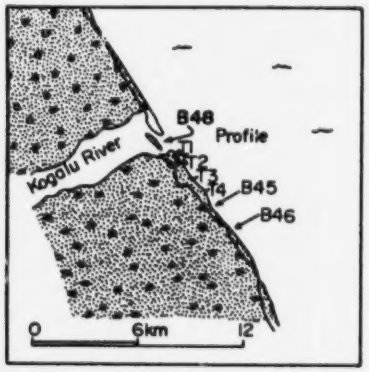



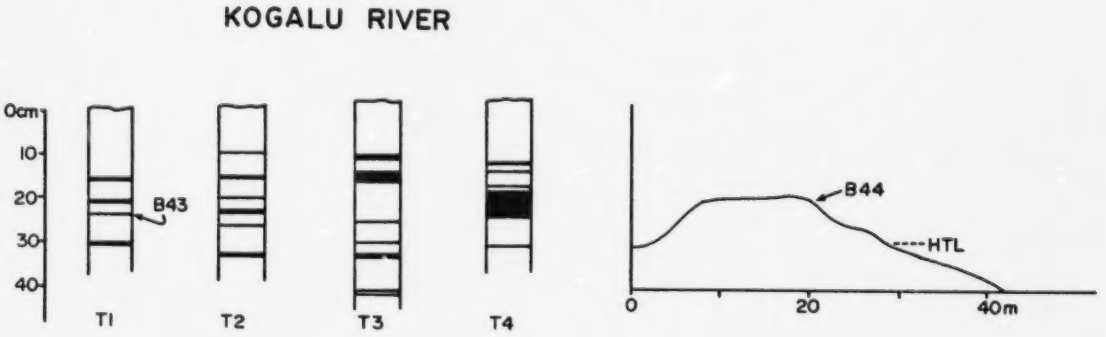



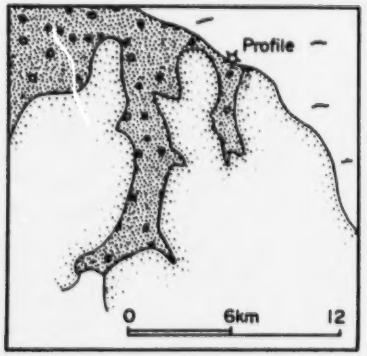

Sample location map with beach profiles and trench stratigraphy, Middle (p. 31, D), and South Barrier (p. 31, E), Bylot Island.

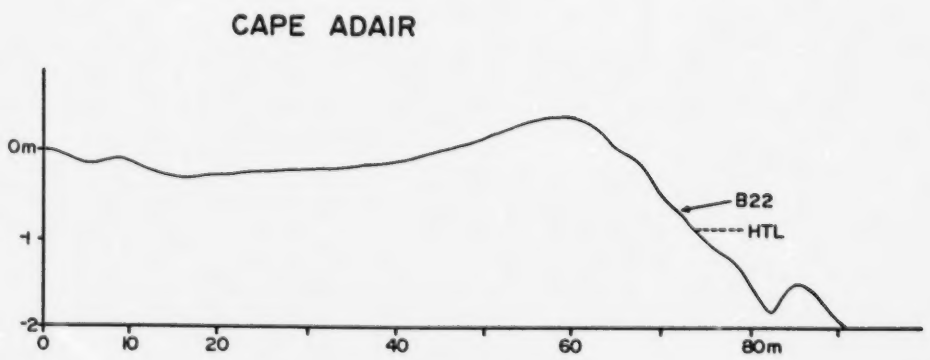



Sample location map with beach profiles, Guys Bight (p. 31, F) and Scott Inlet (p. 31, G), eastern Baffin Island.

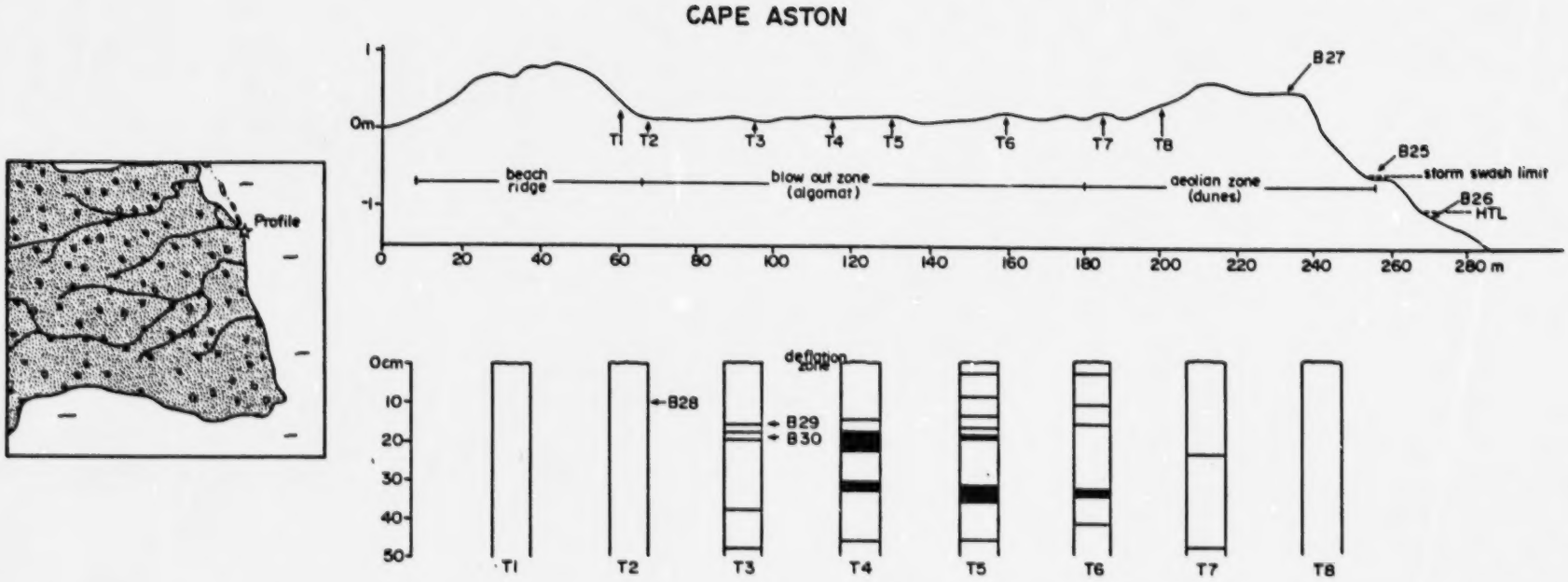



Sample location map with beach profiles and trench stratigraphy, Kogalu River (p. 31, H) and Cape Adair (p. 31, I), eastern Baffin Island.




Sample location map with beach profile and trench stratigraphy, Cape Aston (p. 31, J), eastern Baffin Island.

# APPENDIX B

## Field Description and Grain Size Statistics

COASTAL BEACH

| Location | Sample No. | Depth (cm) | Description | Mean Grain Size (Ø) | Mean Sorting |
|---|---|---|---|---|---|
| Guys Bight | B6 | 5 | river bank | 1.2 | 0.65 |
| | B7 | 5 | berm crest | 1.6 | 0.35 |
| | B8 | 12 | Trench #1 | 1.5 | 0.43 |
| Scott Inlet | B10 | 5 | seaward of the berm | 1.7 | 0.37 |
| South Barrier | B11 | 5 | heavies near gravel bank | 2.0 | 0.25 |
| | B12 | 5 | berm | 2.0 | 0.23 |
| | B13 | 5 | close to river | 1.8 | 0.30 |
| | B14 | 5 | aeolian sands 10cm above active dune | 1.8 | 0.31 |
| | B15 | 5 | foreshore sands | 2.0 | 0.25 |
| Middle Barrier | B17 | 5 | dune crest | 1.8 | 0.36 |
| | B18 | 5 | heavy rich layer | 1.9 | 0.29 |
| | B19 | 20 | clean sands Trench #1 | 1.8 | 0.36 |
| | B20 | 35-38 | heavy rich layer | 1.8 | 0.38 |
| | B21 | 3-5 | clean sands Trench #4 | 1.4 | 0.42 |
| Cape Adair | B22 | 5 | H.T.L. Sands | 0.2 | 0.36 |
| Cape Aston | B25 | 20 | lights under brash ice zone | 1.8 | 0.31 |
| | B26 | 15 | heavies under brash ice zone | 1.7 | 0.30 |
| | B27 | 5 | active aeolian dune | 1.9 | 0.30 |
| | B28 | 10-12 | c sand - Trench #2 | 0.4 | 0.51 |
| | B29 | 16 | heavy rich layer | 1.8 | 0.43 |
| | B30 | 18-19 | clean sands Trench #3 | 1.8 | 0.34 |
| Feachan Bay | B36 | 5 | H.T.L. sands | 1.4 | 0.37 |
| Kogalu River | B43 | 24 | see figure | 1.0 | 0.50 |
| | B44 | 5 | crest of beach | 0.6 | 0.40 |
| | B45 | 5 | 1200' from river | 1.0 | 0.42 |
| | B46 | 5 | 1900' from river | 0.9 | 0.33 |
| | B48 | 5 | river mouth bar | 0.5 | 0.27 |
| Coutts Inlet | B50 | 5 | delta | 1.6 | 1.14 |
| Pond Inlet | B52 | 5 | | 1.7 | 0.38 |
| Cape Hewitt | B23 | 5 | bluff #1 | 2.5 | 1.04 |
| | B24 | 0-45 | old beach ridge | 1.2 | 0.61 |
| | B31 | 5 | white dunes | 1.9 | 0.29 |
| | B32 | 5 | yellow dunes | 1.5 | 0.45 |
| | B33 | 10 | under yellow dunes | 1.8 | 0.43 |

SIDE-ENTRY BEACH

| Location | Sample Number | Depth (cm) | Description | Mean Grain Size (Ø) | Mean Sorting |
|---|---|---|---|---|---|
| McBeth Side-Entry | B53 | 5 | heavy rich layer) | 0.9 | 0.46 |
| | B54 | 13-14 | coarse sands) Trench #2 | 0.8 | 0.47 |
| | B55 | 19-21 | interlayered heavies and lights) | 1.0 | 0.74 |
| | B60 | 5 | heavy rich layer | 1.2 | 0.41 |
| | B61 | 15-17 | clean sands) | 0.8 | 0.32 |
| | B62 | 25-27 | heavy rich layer) Trench #5 | | |
| | B63 | 29-31 | clean sands) | | |
| | B64 | 1-3 | heavy rich layer - Trench #6 | 1.1 | 0.51 |
| | B65 | 1-3 | heavy rich layer) | 1.4 | 0.26 |
| | B66 | 32-34 | clean sands) Trench #7 | 0.9 | 0.34 |
| | B67 | 5 | aeolian sands on snow | 1.2 | 0.50 |
| | B68 | 5 | heavy rich layer) | | |
| | B69 | 10-14 | coarse sands) Trench #3 | | |
| | B70 | 20-30 | interbedded heavies and lights) | | |
| | B71 | 6 | clean sands) | 0.9 | 0.31 |
| | B72 | 13-14 | interbedded heavies and lights - Trench #7 | 1.2 | 0.21 |
| | B73 | 5 | swash zone heavies | 1.1 | 0.39 |
| | B74 | 5 | aeolian sands on snow | 1.2 | 0.28 |
| | B75 | 5 | fluvial sands | 0.3 | 0.51 |
| | B76 | 5 | swash zone | 0.4 | 0.27 |
| | B77 | 5 | swash zone heavies | 1.2 | 0.37 |
| | B78 | 1 | swash zone | 1.1 | 0.34 |
| | B79 | 5 | aeolian sands on snow | 0.5 | 0.44 |
| | B80 | 5 | interbedded heavies and lights | 1.5 | 0.22 |
| | B81 | 5 | stoss side of wave bar | 1.2 | 0.41 |

DELTA (SANDUR)

| Location | Sample Number | Depth (cm) | Description | Mean Grain Size Ø | Mean Sorting |
|---|---|---|---|---|---|
| McBeth | D15 | 2-6 | eroded section of algalmat | | |
| | D16 | 5 | on lee side of snow ripples | 1.1 | 0.65 |
| | D17 | 5 | high tide bar | 0.9 | 0.79 |
| | D18 | 5 | aeolian sands on snow | 1.9 | 0.61 |
| | D19 | 5 | large aeolian dune | 1.9 | 0.61 |
| | D21 | 5 | raised marine sequence | 2.0 | 0.64 |
| | D22 | 5 | river bank | 2.2 | 1.02 |
| | D23 | 31-34) | | | |
| | D24 | 22-26) | tidal flat | 1.4 | 0.34 |
| | D25 | 11-15) | | 1.0 | 0.60 |
| | D26 | 5 ) | | 2.7 | 0.78 |
| | D27 | 5 | alluvial fan | 1.7 | 0.48 |
| Cambridge | D28 | 0-3 | lee side of lower wave bar | 1.4 | 0.46 |
| | D29 | 5 | sym wave ripples | 1.6 | 0.74 |
| | D30 | 0-3 | overwash between 2 wave bars | 1.4 | 0.77 |
| | D31 | 5 | 'air-bubble' sediments | 1.3 | 0.45 |
| | D32 | 5 | trough of lingoid ripple | 1.2 | 0.65 |
| | D33 | 5 | stoss of lingoid ripple | 1.3 | 0.54 |
| | D34 | 7 | algal mat | 1.6 | 0.89 |
| | D35 | 5 | raised fluvial system | 1.4 | 0.50 |
| | D36 | 5 | lateral moraine complex | 0.9 | 0.89 |
| | D37 | 5 | berm | 1.9 | 0.35 |
| | D38 | 5 | raised prodelta | 1.1 | 0.62 |
| | D39 | 5 | alluvial fan | 0.6 | 0.60 |
| | D40 | 5 | suspension fallout on alluvial fan | 2.0 | 1.18 |
| | D41 | 5 | aeolian ripples | 1.9 | 0.60 |

DELTA (SANDUR)

| Location | Sample Number | Depth (cm) | Decription | Mean Grain Size ø | Mean Sorting |
|---|---|---|---|---|---|
| Cambridge | D42 | 5 | river bed | 0.8 | 0.69 |
| | D43 | S | river bed | | |
| | D44 | S | river bed | | |
| | D45 | S | raised delta complex | 2.0 | 0.64 |
| | D46 | S | raised delta complex | 2.7 | 1.01 |
| | D47 | S | raised delta complex | 1.1 | 0.81 |
| | D48 | S | raised delta complex | | |
| | D49 | S | raised delta complex | 1.0 | 0.52 |
| | D50 | S | | | |
| | D51 | S | raised delta complex | 2.8 | 0.48 |
| | D52 | S | midpoint on alluvial fan | 1.6 | 0.64 |
| | D53 | S | bank dep. on alluvial fan | 1.4 | 0.61 |
| | D54 | S | sand on distal portion of alluvial fan | | |
| | D55 | S | fluvial bank | 1.8 | 0.72 |
| | D56 | S | alluvial fan | 1.4 | 0.83 |
| | D57 | S | raised delta sequence | 2.7 | 0.40 |
| | D58 | S | alluvial fan | 0.7 | 0.67 |
| | D59 | S | mouth of alluvial fan | 0.7 | 0.63 |
| | D60 | S | fluvial bank | 1.4 | 0.88 |
| | D61 | S | mouth of alluvial fan | 1.3 | 0.78 |
| | D62 | S | sand sheet deposit | 1.3 | 0.64 |
| | D63 | S | raised delta sequence | 1.3 | 0.74 |
| | D64 | S | symmetrical wave ripples | | |

PRODELTA

| Location | Sample No. | Water Depth (m) | Mean Grain Size (Ø) | Mean Sorting |
|---|---|---|---|---|
| McBeth | PD8 | | 2.6 | 0.69 |
| | PD10 | | 1.1 | 0.70 |
| | PD11 | | 2.1 | 1.18 |
| | PD12 | | 3.5 | 0.65 |
| | PD13 | | 3.5 | 0.55 |
| | PD14 | | 3.5 | 0.65 |
| Cambridge | PD21 | | 2.1 | 1.04 |
| | PD22 | | 2.2 | 0.98 |
| | PD23 | | 2.3 | 0.76 |
| | PD24 | | 2.7 | 0.84 |
| | PD25 | | 3.2 | 0.78 |
| | PD26 | | 2.9 | 0.85 |
| | PD27 | | 2.5 | 0.94 |
| | PD28 | | 2.4 | 0.99 |
| | PD29 | | 3.2 | 0.64 |
| | PD31 | | 3.3 | 0.76 |
| | PD36 | | 1.3 | 0.79 |
| | PD37 | | 1.7 | 1.03 |
| | PD38 | | 1.6 | 1.10 |
| | PD39 | | 2.2 | 1.08 |
| | PD42 | | 2.8 | 0.86 |
| | PD44 | | 2.2 | 0.93 |
| McBeth | PD81 | | 2.7 | 0.66 |
| | PD82 | | 3.7 | 0.50 |

# APPENDIX C

## Heavy Mineralogy and Abundances

## COASTAL BEACH

| Sample No. | Weight % Heavies | No. % Gar. | No. % Opq. | No. % Pyx. | No. % Amp. | No. % Sill. | No. % Tou. | No. % Sph. | No. % Zir. | No. % Epi. | No. % Oli. | No. % Hem. | No. % Sta. | No. % Rut. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| B6 | 34 | 88 | 5 | 2 | 3 | | | | | | | T | | |
| B7 | 45 | | | | | | | | | | | | | |
| B8 | 51 | | | | | | | | | | | | | |
| B10 | 47 | 12 | 45 | 8 | 29 | | | 1 | T | | 1 | | | |
| B11 | 57 | | | | | | | | | | | | | |
| B12 | 55 | | | | | | | | | | | | | |
| B13 | 96 | 61 | 29 | 3 | 3 | | | | | | 3 | | | |
| B14 | 27 | 72 | 8 | 11 | 3 | | | | | | 7 | | | |
| B15 | 1 | | | | | | | | | | | | | |
| B17 | 81 | | | | | | | | | | | | | |
| B18 | 82 | 24 | 10 | 47 | 2 | | | | T | | 17 | | | |
| B19 | 7 | 38 | 17 | 28 | 1 | | | | | | 14 | | | |
| B20 | 60 | | | | | | | | | | | | | |
| B21 | 17 | | | | | | | | | | | | | |
| B22 | 1 | Primarily pyroxene and hornblende rock fragments in heavy fraction | | | | | | | | | | | | |
| B25 | 1 | | | | | | | | | | | | | |
| B26 | 18 | | | | | | | | | | | | | |
| B27 | 8 | | | | | | | | | | | | | |
| B28 | - | | | | | | | | | | | | | |
| B29 | 3 | 15 | 51 | 6 | 25 | | | 2 | | 1 | | | | |
| B30 | - | | | | | | | | | | | | | |
| B36 | 95 | 33 | 37 | 3 | 24 | | | 1 | 2 | 1 | | | | |
| B43 | 45 | | | | | | | | | | | | | |
| B44 | 3 | | | | | | | | | | | | | |
| B45 | 88 | | | | | | | | | | | | | |
| B46 | 41 | 5 | 20 | 7 | 60 | | T | | 5 | 2 | | | | |
| B48 | 1 | | | | | | | | | | | | | |
| B50 | 18 | | | | | | | | | | | | | |
| B52 | 88 | 44 | 43 | 5 | 8 | | | | T | | | | | |
| B23 | 2 | | | | | | | | | | | | | |
| B24 | 2 | | | | | | | | | | | | | |
| B31 | - | | | | | | | | | | | | | |
| B32 | 1 | | | | | | | | | | | | | |
| B33 | 1 | | | | | | | | | | | | | |

SIDE-ENTRY BEACH

| Sample Number | Weight % Heavies | No.% Gar. | No.% Opq. | No.% Pyx. | No.% Amp. | No.% Sill. | No.% Tou. | No.% Sph. | No.% Zir. | No.% Epi. | No.% Oli. | No.% Hem. | No.% Sta. | No.% Rut. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| B53 | 26 | | | | | | | | | | | | | |
| B54 | 20 | | | | | | | | | | | | | |
| B55 | 22 | | | | | | | | | | | | | |
| B60 | 58 | | | | | | | | | | | | | |
| B61 | 2 | | T | 9 | 87 | | | 2 | | | 2 | | | |
| B62 | 43 | 1 | 6 | 8 | 78 | | 1 | | T | 4 | 3 | | | |
| B63 | 1 | | | | | | | | | | | | | |
| B64 | 21 | | | | | | | | | | | | | |
| B65 | 92 | | | | | | | | | | | | | |
| B66 | 14 | | | | | | | | | | | | | |
| B67 | 79 | | | | | | | | | | | | | |
| B68 | 53 | 3 | 7 | 12 | 76 | | | T | | | | | | |
| B69 | 4 | 1 | 1 | 3 | 95 | | | T | | | | T | | |
| B70 | 14 | 1 | 1 | 24 | 71 | | | T | | | 2 | | | |
| B71 | 10 | | | | | | | | | | | | | |
| B72 | 50 | | | | | | | | | | | | | |
| B73 | 46 | | | | | | | | | | | | | |
| B74 | 18 | | | | | | | | | | | | | |
| B75 | 3 | | | | | | | | | | | | | |
| B76 | 2 | | | | | | | | | | | | | |
| B77 | 20 | | | | | | | | | | | | | |
| B78 | 10 | | | | | | | | | | | | | |
| B79 | 7 | | | | | | | | | | | | | |
| B80 | 54 | | | | | | | | | | | | | |
| B81 | 11 | | | | | | | | | | | | | |

DELTA (SANDUR)

| Sample Number | Weight % Heavies | No.% Gar. | No.% Opq. | No.% Pyx. | No.% Amp. | No.% Sill. | No.% Tou. | No.% Sph. | No.% Zir. | No.% Epi. | No.% Oli. | No.% Hem. | No.% Sta. | No.% Rut. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| D15 | 3 | 10 | 17 | 16 | 17 | 6 | 10 | | 2 | 3 | | 2 | | T |
| D16 | 3 | | | | | | | | | | | | | |
| D17 | 6 | 53 | 22 | 3 | 16 | 3 | 1 | | | | 1 | 3 | | |
| D18 | 49 | | | | | | | | | | | | | |
| D19 | 4 | | | | | | | | | | | | | |
| D21 | 4 | | | | | | | | | | | | | |
| D22 | 7 | | | | | | | | | | | | | |
| D23 | 6 | 8 | 3 | 5 | 4 | 2 | 71 | | T | | | 7 | | |
| D24 | 2 | | | | | | | | | | | | | |
| D25 | 3 | | | | | | | | | | | | | |
| D26 | 7 | 14 | 4 | 17 | 2 | 1 | 57 | | 1 | | | 3 | | 1 |
| D27 | 27 | 9 | 41 | 8 | 34 | | | 4 | 2 | 2 | | T | | |
| D28 | | | | | | | | | | | | | | |
| D29 | | | | | | | | | | | | | | |
| D30 | 8 | | | | | | | | | | | | | |
| D31 | 8 | 2 | 32 | 4 | 50 | T | 1 | 3 | 2 | 3 | | T | | |
| D32 | 10 | | | | | | | | | | | | | |
| D33 | 5 | | | | | | | | | | | | | |
| D34 | 8 | 2 | 52 | 1 | 30 | T | 4 | 4 | 2 | 3 | | | 1 | |
| D35 | 4 | | | | | | | | | | | | | |
| D36 | 4 | T | 31 | 20 | 45 | | 1 | 1 | T | | 2 | | | |
| D37 | 13 | | | | | | | | | | | | | |
| D38 | | | | | | | | | | | | | | |
| D39 | 3 | | | | | | | | | | | | | |
| D40 | 11 | | | | | | | | | | | | | |
| D41 | 9 | 2 | 45 | 2 | 39 | | 2 | 1 | 2 | 6 | | | | |

DELTA (SANDUR)

| Sample Number | Weight % Heavies | No. % Gar. | No.% Opq. | No.% Pyx. | No.% Amp. | No.% Sill. | No.% Tou. | No.% Sph. | No.% Zir. | No.% Epi. | No.% Oli. | No.% Hem. | No.% Sta. | No.% Rut. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| D42 | 10 | | | | | | | | | | | | | |
| D43 | 75 | 5 | 83 | 10 | | | | 1 | T | 1 | | | T | |
| D44 | | | | | | | | | | | | | | |
| D45 | 10 | | | | | | | | | | | | | |
| D46 | 9 | 10 | 42 | 5 | 7 | | 19 | 2 | 3 | 8 | | 4 | | |
| D47 | 3 | | | | | | | | | | | | | |
| D48 | | | | | | | | | | | | | | |
| D49 | 4 | | | | | | | | | | | | | |
| D50 | 2 | | | | | | | | | | | | | |
| D51 | 9 | | | | | | | | | | | | | |
| D52 | 16 | 1 | 79 | 2 | 10 | | 1 | 2 | 1 | 3 | | | | |
| D53 | 24 | | | | | | | | | | | | | |
| D54 | 15 | | | | | | | | | | | | | |
| D55 | 6 | | | | | | | | | | | | | |
| D56 | 11 | | | | | | | | | | | | | |
| D57 | 10 | | | | | | | | | | | | | |
| D58 | 8 | | | | | | | | | | | | | |
| D59 | 10 | | | | | | | | | | | | | |
| D60 | 5 | | | | | | | | | | | | | |
| D61 | 3 | | | | | | | | | | | | | |
| D62 | 5 | | 32 | 7 | 48 | - | 9 | 3 | | | T | | | |
| D63 | 26 | | | | | | | | | | | | | |
| D64 | 8 | | | | | | | | | | | | | |

PRODELTA

| Sample No. | Weight % Heavies | No.% Gar. | No.% Opq. | No.% Pyx. | No.% Amp. | No.% Sill. | No.% Tou. | No.% Sph. | No.% Zir. | No.% Epi. | No.% Oli. | No.% Hem. | No.% Sta. | No.% Rut. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PD8 | 5 | 2 | 10 | 20 | T | 7 | 55 | | T | | | 6 | | |
| PD10 | 6 | 6 | 21 | 19 | | 8 | 42 | | | | | 3 | | |
| PD11 | 2 | | | | | | | | | | | | | |
| PD12 | 9 | 23 | 10 | 7 | T | 1 | 55 | | 2 | 1 | | | | |
| PD13 | 11 | | | | | | | | | | | | | |
| PD14 | 9 | 3 | 11 | 1 | | | 81 | | | | | 4 | | |
| PD21 | 8 | | | | | | | | | | | | | |
| PD22 | 6 | | | | | | | | | | | | | |
| PD23 | 10 | | | | | | | | | | | | | |
| PD24 | 10 | | | | | | | | | | | | | |
| PD25 | 9 | | | | | | | | | | | | | |
| PD26 | 10 | | | | | | | | | | | | | |
| PD27 | 8 | | | | | | | | | | | | | |
| PD28 | 8 | | | | | | | | | | | | | |
| PD29 | 11 | 12 | 40 | | 25 | | 7 | 5 | 5 | 4 | | 1 | | 1 |
| PD31 | 9 | | | | | | | | | | | | | |
| PD36 | 5 | | | | | | | | | | | | | |
| PD37 | | 7 | 9 | | 59 | | 14 | 4 | 1 | 3 | | 3 | | |
| PD38 | 6 | | | | | | | | | | | | | |
| PD39 | 8 | | | | | | | | | | | | | |
| PD42 | 10 | | | | | | | | | | | | | |
| PD44 | 7.5 | | | | | | | | | | | | | |
| PD81 | 7 | | | | | | | | | | | | | |
| PD82 | 9 | | | | | | | | | | | | | |

Legend:

S = Surface
T = Trace
Gar. = Garnet
Opq. = Opaques
Pyx. = Pyroxene
Amp. = Amphibole
Sill.= Sillimanite
Tou. = Tourmaline
Sph. = Sphene
Zir. = Zircon
Epi. = Epidote
Oli. = Olivine
Hem. = Hematite
Sta. = Staurolite
Rut. = Rutile